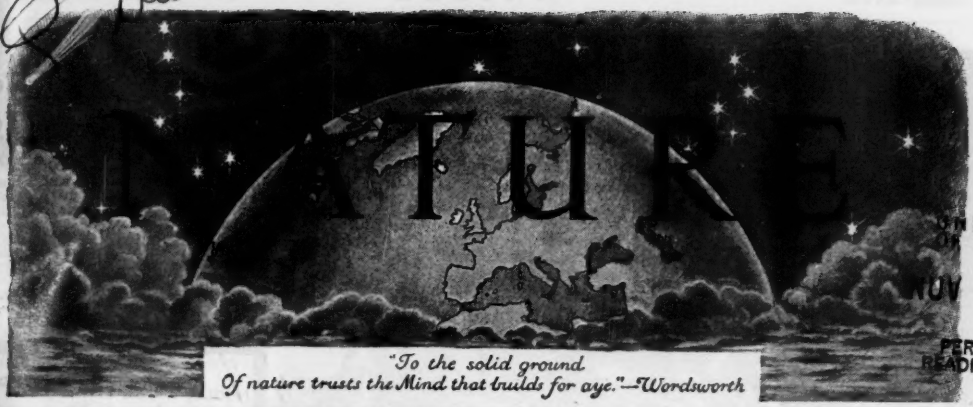

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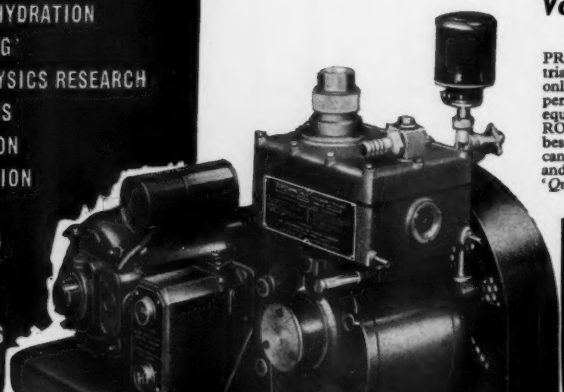

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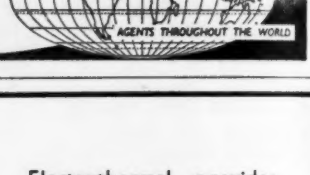

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GOVERNMENT ORGANIZATION OF RESEARCH

IN view of the attempts which are frequently made to compare both the magnitude and the organization of the research effort in Great Britain with that in the United States, the report "Organization of the Federal Government for Scientific Activities" which has recently been issued by the National Science Foundation in its National Science Studies series is of considerable interest*. It is one of a series of publications which set forth the basic facts concerning the scientific research effort of the United States, and is the outcome of a study made by the National Science Foundation in 1954 and 1955. It covers not only the conduct of research and development but also their planning and administration and the expansion of facilities for this purpose, the training of scientific man-power and the dissemination of scientific information, as well as the collection of statistics in the natural and social sciences and such matters as testing, evaluation and standardization.

The report is in two parts, the first being a direct sequence to the Steelman Report of 1947, and giving special attention to subsequent developments. The second, which occupies more than three hundred of the 340 pages, describes the organization for scientific activities of each department and agency of the Federal Government. It does not attempt to give more than a summary of the scientific effort of the Government as a whole, though the nature of the scientific programme of the thirty-eight departments and agencies is briefly indicated.

This second part of the report should serve as a reference work on the scientific activities of the Federal Government, to which there is nothing parallel in Great Britain either in scope or scale. Thus in Britain the account of "Government Scientific Organization in the Civilian Field" which the Advisory Council on Scientific Policy produced in July 1951 does not deal with the defence departments, nor does it indicate the man-power employed by the various departments and agencies on scientific activities, excluding grants to the universities through the Universities Grants Committee. Without fuller knowledge of the man-power and resources involved —as is provided in the American report for the United States—effective discussion of the scale and direction of the scientific effort of Britain is hamstrung, as was evident in the recent discussions on the Department of Scientific and Industrial Research Bill. Mr. James Callaghan, for example, in urging on July 16 in the House of Commons the need for more effective co-ordination in research, particularly between the Service Departments and the Civil Departments, put the present expenditure on research at £235 million, of which the Department of Scientific and Industrial Research was responsible only for some £10 million. He could, however, only add that, for the rest, the great bulk of the expenditure was on the research side.

The National Science Foundation does not in this report give the total Federal expenditure on research, though it points out that in 1954 defence research accounted for 86 per cent of the Federal expenditure on research, as compared with an estimated 20 per cent in 1938. Figures given in the report put the total expenditure on defence at little short of 19,000 million dollars out of 23,500 million and the scientific staff at some 23,000, of whom all but 191 are in one or other of the three Services, out of a total of 45,000 scientists in Government service. The analysis is made by departments and agencies but gives the expenditure and personnel devoted to scientific activities as compared with that devoted to the total activities of the department or agency and not necessarily that given to research alone. Even so, we are left with a much clearer picture of the scientific effort of the Federal Government, in which the magnitude of its research effort can be fairly clearly discerned.

This is assisted by the way in which the report directs attention to the major developments in the Federal Organization for Scientific Activities since 1947. In 1953, for example, the research functions of the Department of Agriculture were reorganized, the Bureau of Agricultural Economics being abolished and its functions distributed between the Agricultural Research Service, to which was assigned all the production and utilization research of the Department, except forestry research, and the Agricultural Marketing Service, which was made responsible for marketing research and related statistical and economic research. The Agricultural Research Service was also made responsible for the conduct of the soil conservation research, previously carried out by the Soil Conservation Service, for certain grass and range-management research, formerly done by the Forest Service, and for some of the research and development work from the Foreign Agricultural Service. The Department's expenditure in 1954 totalled 750 million dollars, of which just over 76 million went on scientific activities, in which 3,848 out of its scientific staff of 16,123 (out of a man-power force of 77,405) were engaged.

Nuclear research and production was transferred from military to civilian control in January 1947; but it was more than a year later that the Manhattan Engineer District transferred the last of its contracts to the Atomic Energy Commission, the expenditure of which in 1954 totalled just over 1,417 million dollars; of this total 266 million dollars was on scientific activities, in which 99 out of its 1,009 scientific staff were engaged. The staff of the Commission totals 6,029, but about two-thirds of the research and development programme is conducted in Government-owned facilities operated under contract by industrial and institutional contractors, and of these the Ames Laboratory, Bettis Plant and the Brookhaven National Laboratory have been established since 1947. In its early years, the Commission's research and development programme was organized

* National Science Foundation. Organization of the Federal Government for Scientific Activities. Pp. vii+349. (Washington, D.C.: Government Printing Office, 1956.) 1.75 dollars.

in five divisions: production, research and development, engineering, military application, and biology and medicine. In 1949 the Division of Engineering was placed within a new Division of Reactor Development, the Division of Research participating in advanced reactor work and supporting research, while in 1954 an assistant general manager of research and development was appointed. It is emphasized that scientists have consistently occupied key roles in the formulation of policy, and close working relations have been maintained between the Division of Military Application and the Armed Forces Special Weapons Project, the Military Liaison Committee serving as the major means of interchange of advice and information with the Department of Defence at the policy level.

The Department of Commerce, with a total expenditure of nearly 990,000,000 dollars and a staff of 41,539, employs a staff of 6,486 scientists, of whom 2,679 are engaged in scientific activities on which 65,804,000 dollars were expended. Its research activities are on quite disparate subjects and the National Bureau of Standards, the Bureau of the Census, the Weather Bureau and the Coast and Geodetic Survey have a relatively high degree of autonomy. From 1947, increasing use was made of the National Bureau of Standards as a general purpose physical laboratory for defence research; but in 1954 staff and facilities engaged in ordnance work for the Army were reconstituted as an activity of the Army Ordnance Corps and a group engaged on naval missile development was transferred to the Bureau of Ordnance of the Navy Department. A third group, the Institute for Numerical Analysis, was transferred to the administrative control of the University of California at Los Angeles.

The Department of Defense, with a total expenditure of 553,000,000 dollars, of which some 21,675,000 dollars is on scientific activities, employed 191 scientists, excluding all military personnel, in 1954, of whom 89 were engaged in scientific activities. The situation in each of the military departments, in spite of the major changes in the organization for military research and development since 1947, is regarded as still in flux. Under the National Security Act of 1947, the Secretary of Defense has broad responsibilities for unifying the activities of the three military departments and specifically for eliminating unnecessary duplication in research; but in 1953 the President's Advisory Committee on Government Organization recommended abolition of the Research and Development Board which had been established to assist the Secretary of Defense in this task. This Board was responsible for the preparation of an integrated military research and development programme, and for advising on trends in scientific research relevant to national defence as well as for recommending measures of inter-service co-ordination and allocation of responsibilities. The Board was assisted by a staff of several hundred, both civil and military, and by more than two thousand consultants, as well as by a network of committees and panels. The latter, generally consisting of scientists outside the Government, advised on work undertaken in the major scientific disciplines. Besides considering the major programmes and the research and development budget, the Board was concerned with such problems as the assignment of responsibilities, the common use of facilities and the recruitment of scientific manpower, and it developed a system for classifying the research and development effort into categories and programmes, and for relating these to the operational needs of the military services.

The functions of the Board were thus much wider than those of the Defence Research Policy Committee in Great Britain, and its resources were obviously much greater. It is considered that the Board was particularly useful in providing a forum for reconciling the diverse points of view of the three Services and for the exchange of information on activities of common concern. The plan which abolished this Board in 1953 assigned the responsibility for research and development to a new Assistant Secretary of Defense (Research and Development), assisted by a Research and Development Policy Council. Retaining part of the Board's staff and some of the panels and committees, this Assistant Secretary of Defense has broad powers of formulating and co-ordinating policy over military research and development programmes and exercises other functions for which the Board was previously responsible.

In June 1955, the Commission on Organization of the Executive Branch of the Government further recommended (see *Nature*, **176**, 1012; 1955) the regrouping of the functions of the Office of the Secretary of Defense in the four management fields of logistics, research and development, personnel and finance, each under an assistant secretary. Under this arrangement the assistant secretary (research and development) would assume responsibilities now divided between him and the assistant secretary (applications engineering). It was also recommended that supervisory duties in each military department be divided among those same few assistant secretaries and that each departmental assistant secretary (research and development) should be a person with a technical background and should co-ordinate research and development within his department. This latter recommendation was included in the Reorganization Plan submitted to Congress on May 15, 1956. There is also an Assistant to the Secretary of Defense (Atomic Energy), who is chairman of the Military Liaison Committee, which is the focal point for liaison of policy between the Atomic Energy Commission and the Department of Defense, while besides the Weapons System Evaluation Group there also reports to the Assistant Secretary of Defense (Research and Development), and to each Chief of Staff, the Armed Forces Special Weapons Project, established in 1946.

Organization for research and development differs somewhat in the three Services in the United States. In August 1955 the Secretary of the Army established the new post of Director of Research and Development, and in September 1955 the post of military chief of research and development was raised to deputy chief of staff level. Like the other military services, the Army has established a committee of

outstanding scientists and industrialists to advise on its research and development programmes; but besides its responsibility, since June 1954, for co-ordinating the Navy's research and development programmes, the Office of Naval Research has since 1947 been one of the main sources of Government financial support of basic scientific research. The Department of the Air Force was the first of the military departments to establish a higher research and development post (at Secretary level), and in August 1955 appointed a former director of the Bell Laboratories to the post of Secretary of the Air Force. In 1955 about two dozen research centres were engaged almost entirely on contracts for the three military departments.

The Department of Defense in the United States is thus concerned with research, including fundamental research, to a far greater extent than obtains in Great Britain, and the picture of the distribution of man-power given by the recent Zuckerman report (see *Nature*, Oct. 27, p. 887) does not suggest that the nation's research effort is widely different in pattern from that indicated by Mr. Callaghan last July. The 13,900 scientists and engineers in Government service in 1956 represent some 10 per cent of the total employed, and about 7,600 of them are employed in the defence departments. There is, however, no estimate of the proportion engaged on research and development, and the figures for the Ministry of Supply may well include many who in the United States would appear under the Department of Defense.

So far as the United States is concerned, the Department of Defense seems to reflect faithfully, in staff and expenditure, the magnitude of the national pre-occupation with defence, and there appears to be a continuing concern that that effort shall be expended as efficiently and fruitfully as possible from the point of view of the general national interest. There is less apparent evidence of such concern in Britain, and the recent report of the Select Committee on Estimates suggests that, at least in regard to the Navy's expenditure on research and development, there is need for a continuing review by some body with stronger authority than the Defence Research Policy Committee in order to avoid waste and duplication. The very magnitude of the effort in defence research and development in Britain, even when all allowance is made for possible benefit and repercussions in other fields, makes it imperative that there should be continuous co-ordination and supervision to prevent unbalanced development and the expenditure of resources unwisely in too limited a field.

Of the other major changes in the Government organization for research in the United States since 1947 emphasized in this report, the establishment in 1953 of the Department of Health, Education and Welfare must be mentioned. This Department expended in 1954 some 78 million dollars out of 2,000 million dollars on scientific activities; and of its 35,730 employees, 3,790 were scientists and 1,886 were engaged in scientific activities. Most of the research done in the Department is carried out by the Public Health Service, and since 1948 has been largely guided by the Research Planning Council, while at the same time an Office of Research Planning was established to maintain information on current research projects, compile data and develop methods of appraising fields in which research should be expanded or contracted. Most public health research is carried out at the Institutes of Health or under contracts or grants. Some other research in the Department in the biological and physical and social sciences is in support of the Food and Drug Administration, the Office of Vocational Rehabilitation or the Office of Education, and in 1955 the educational research activities of the latter were placed under an assistant commissioner for co-ordination of educational research activities.

The organization for scientific work within the Bureaux of the Department of the Interior, which expended in 1954 some 83 million dollars on scientific activities out of 527 million dollars, has not greatly changed since 1947. It employed 9,307 scientists in a staff of 55,279, and of these 4,725 were engaged in scientific work. The Bureau of Mines was reorganized on a regional basis in 1949 and in January 1955 the number of regional offices was reduced from nine to five. In 1954 the Fish and Wildlife Service extended its activities in fishery technology, market development and fishery biology, and like the Geological Survey, the National Parks Service and the Bureaux of Mines and Reclamation, carries on scientific work in the biological, physical and social sciences. In 1953 the programme staff of the Department was replaced by a technical review staff.

The whole of the National Advisory Committee for Aeronautics, with an expenditure of 57 million dollars, which has doubled its programme since 1947, carries on scientific activities and 2,279 of its staff of 7,150 are scientists. Under the Unitary Wind Tunnel Plan, the Committee is responsible for constructing and operating certain facilities primarily to meet the needs of the Department of Defense and the aircraft industry for the development and testing of aircraft, missiles and propulsion systems.

Of the National Science Foundation itself, it will suffice to add here that its expenditure in 1954 was 7,913,000 dollars, and its scientific staff numbered 37 out of 151. One of the latest of the Federal Government's research programmes is that begun early in 1947 and known as Veterans' Administration. It arose out of the recognition that the demand for medical care by eligible veterans of the Second World War would increase greatly. Since 1947 its support of research has shifted from that by outside investigators on contract to intramural research, and the policy has been increasingly followed of maintaining many small laboratories dispersed among the Administration's hospitals. Of its expenditure of 4,400 million dollars in 1954, 5,343,000 dollars was on scientific activities in which, however, only 334 out of its scientific staff of 10,253 were engaged.

The report directs special attention to two science committees: the Interdepartmental Committee on Scientific Research and the Science Advisory Committee of the Office of Defense Mobilization. The latter was set up in 1951 to direct attention to new

developments of science of significance for the national security, and to advise on the effective utilization of scientific resources so as to assure their availability in mobilization. The former, the need for which was emphasized both by Dr. Vannevar Bush's report in 1945 and by the Steelman report in 1947, was established in 1947 to study and make recommendations in relation to the research and development programmes of the Government and the promotion of national welfare; increasing the administrative efficiency of Federal research and development programmes; and Federal policies and practices in support of research.

PROF. NORBERT WIENER: AN AUTOBIOGRAPHY

I Am a Mathematician

By Prof. Norbert Wiener. Pp. 380. (London: Victor Gollancz, Ltd., 1956.) 21*s.* net.

AUTOBIOGRAPHIES of mathematicians are not common; a book, therefore, by Prof. Norbert Wiener dealing with his adult life and mathematical development is of special interest. It can scarcely be said that mathematics ordinarily leads to the kind of life which would interest the general reader, but Prof. Wiener is no ordinary mathematician; his interests are far wider than the title of this book might suggest. They embrace, in addition to most branches of mathematics itself, electrical engineering, aspects of mathematical physics, neurophysiology, statistics and, to use a word which he himself invented, cybernetics. Moreover, Prof. Wiener has travelled extensively in the course of his life. A resident of Cambridge, Massachusetts, he has spent long periods in Cambridge, England, and is familiar with most European countries; of his travels farther afield, he has much to say of interest about Japan, China, India and, in his own hemisphere, Mexico.

The volume under review is not a complete autobiography; it is a companion to an earlier book entitled "Ex Prodigy", and deals with the author's life from the time of his first appointment, at the age of twenty, to the Department of Mathematics in the Massachusetts Institute of Technology, where he is now professor. It is throughout an interesting book, frankly written in a free and readable style. In the preface the author analyses the motives which led him to undertake this work. "Why did I assume this uninviting labour, which at best can add little to my stature as a working scientist and at worst must offer new opportunities for those who may be inclined to criticise me? All in all, I don't know. There have certainly been motives of literary vanity and the desire to show that, both as an individual and as a scientist I have been able to accomplish a task off my regular beat." Further on, other and less subjective reasons are given to which those acquainted with the author and his work will give greater weight.

Part of the book is, of course, taken up with accounts of the author's mathematical researches. These are numerous and varied; even mathematicians may be surprised at the number and scope of the researches which he has inspired. It is characteristic of the man that much of his work has been done in collaboration with others. Attempts to explain mathematical researches in everyday language to non-mathematicians almost always fail, and even Prof. Wiener is not really successful in passages of this kind. These sections of the book—happily short—are the least interesting. Many readers, particularly students of the subject, will enjoy most of all the stories of his contacts with well-known mathematicians of the past and the present. The book abounds with these, all quite short, but often illuminating. Such a one, taken from his account of the mathematical congress at Strasbourg in 1920, may be quoted: "Camille Jordan, who for all his ninety years accompanied us on our pedestrian excursions, was like a memory from the days of Louis Philippe. His recollections dated back to the great days when Cauchy was lording it over French mathematics and forcing all the younger men to pay tribute."

Readers of this book who do not know Prof. Wiener personally will be surprised and pleased to learn that, in spite of his many achievements, he is still only just past sixty years of age. His concluding remarks are: "How many years may be granted me—I do not know; but even now I can feel reasonably sure that my scientific career, though it began early, is lasting late." All readers of this book will sincerely hope that this proves to be so, and that we may, perhaps, have in due course the pleasure of reading a third instalment of this fascinating autobiography.

H. Jones

EXPERIMENTAL DESIGN AND STATISTICS FOR BIOLOGICAL WORKERS

Experimental Design and Its Statistical Basis

By Dr. D. J. Finney. (The Scientist's Library: Biology and Medicine.) Pp. xi+169. (Chicago: University of Chicago Press; London: Cambridge University Press, 1955.) 30*s.* net.

MANY text-books on experimental design tend to concentrate on the combinatorial aspects of the subject and on methods of analysis. (The notable exception is, of course, Sir Ronald Fisher's original treatise.) As a result, many biological research workers and students are discouraged in their efforts to appreciate the subject, while others, more persistent or perhaps more mathematically minded, have their attention directed from the ideas on which theory and practice are based to questions of technical detail.

Dr. D. J. Finney has written his book especially for these workers and students. They should find it a valuable and well-written account of the principles of a difficult subject. The basic ideas are clearly stated, and examples drawn from many fields of biological work are given at each stage of development. The most important experimental arrangements or plans are surveyed, including randomized blocks, Latin squares and incomplete blocks. An excellent short account of factorial experiments is also included. Here rather more prominence is given to fractional replication than to confounding, although the latter is, in practice, the more useful device. There is also a useful chapter on the various types of sequential experiment now under development. This is followed by a discussion of biological assay which serves to show how the principles of experimental design have been applied in a particular

field. The last chapter is of special interest, as it deals with topics which are sometimes thought to be outside the province of statistics. Here the author briefly discusses the ways in which statistics can help decisions to be reached on questions relating to the choice of treatments and experimental units, and to the type and number of experiments which should be undertaken.

Technical detail has been kept to a minimum throughout the book; but some discussion of methods of analysis has been considered necessary. The sections including these discussions, particularly those connected with tests of significance, are among the most difficult in the book. Those who are uninitiated in the mysteries surrounding tests of significance may take heart from Dr. Finney's remark on p. 41 that "emphasis has been placed on the making of tests of significance, but more often the real purpose of an experiment is to estimate one or more treatment effects". Indeed, readers would do well to underline these words, for the point they express is all too often overlooked.

Altogether this book contains a considerable amount of advice which biological research workers should find of great value. H. D. PATTERSON

WAR-TIME FOOD RATIONING IN BRITAIN

Food, Vol. 2: Studies in Administration and Control
By R. J. Hammond. Pp. xiii+835. (History of the Second World War: United Kingdom Civil Series. Edited by Sir Keith Hancock.) (London: H.M. Stationery Office and Longmans, Green and Co., Ltd., 1956.) 50*s*. net.

IN this, the second of three volumes about food control in Britain during the Second World War, Mr. R. J. Hammond provides a number of studies of the methods used for controlling such commodities as fish, milk, eggs and potatoes, which (since they were wholly or mainly home-produced and did not have to pass through a manufacturing process on their way to the consumer) were particularly difficult to regulate. He also deals in some detail with the emergency services which the Ministry of Food devised in case the normal system of distribution should break down under air attack or invasion—the arrangements for supplying bread and milk to bombed cities, the meals provided for air-raid victims and shelterers, the 'iron-ration' dumps, etc. But the part of the book most likely to be of interest to students of administrative techniques is the section which deals, diffusely—and yet here and there with a tantalizing incompleteness—with the numerous inter-related problems connected with consumer rationing.

It would not perhaps be entirely fair to blame Mr. Hammond for the diffuseness. The system which grew up was bewilderingly complex, and its roots, which he examines with some care, were more than a little tangled. Less fortunate than those concerned with rationing in the First World War, the administrators and politicians concerned with such problems in the Second had before them a large body of imposing but, as it proved, largely misleading precedent, handed down by their predecessors, who had dealt very successfully with other, and less exigent, problems some twenty years earlier. "Precedent", says Mr. Hammond justly, "is the uncritical recourse to history"; and he attributes many of the difficulties which the rationers experienced in the Second World War to the *catalogue non-raisonné* officially handed down to them from the First. This indeed, with the important lesson it holds for the future, not only of this but of other large-scale operations, is the central theme of his brief and comparatively crisp concluding chapter. In his view—and having seen the evidence, it is impossible not to agree with him—"It would certainly be a cardinal error to base any future scheme on the forms and documents that were eventually achieved in the Second World War, without regard to the circumstances they were designed to serve, or the processes by which they came into being. This account of those processes will be justified, practically speaking, only if it drives home the warning that the most dangerous legacy a rationing scheme can leave behind is a collection of its forms and instructions."

Mr. Hammond's second main point is that the Ministry was fortunate in having to deal with a war of attrition, a long-drawn-out struggle of a kind to which its rationing system, "dogged, painstaking, a trifle slow in its movements", was eminently suited. He points out that the continuous refashioning it underwent, from 1941 onwards, was untroubled by massive air attacks, heavy movements of population, or frequent and violent changes of ration-levels; and he concludes that "there must remain some doubt whether, even discarding such things, the system would work at all in a war of a different kind".

The feature of the British rationing system which, above all others, made it difficult to work and impossible to introduce quickly, was the tie between the retailer and the consumer. When tea rationing was introduced late in the War, the tie was dispensed with, and despite what had come to be the traditional prejudices of the officials, the simpler system was seen to be quite workable. Mr. Hammond suggests that in this particular connexion Lord Woolton, bringing a fresher mind to the problem, was able to teach officials a useful lesson in method. "The contrast between their freshness in device", he adds, "and their reluctance to bring sustained criticism to bear on basic notions, is a striking feature of British food control."

Mr. Hammond permits himself one or two other significant asides upon various aspects of the official psychology. He mentions in a footnote that the clothing ration book had at first an impressive series of panels inside the front cover, with figures and letters labelled "for official use only". When this disappeared, the Ministry of Food's Rationing Division, says Mr. Hammond, "asked respectfully and with professional interest, what the change betokened". The reply was that it had been put there to fill up space and make the book appear more official! He quotes, too, in an appendix, the *cri de cœur* of a Stationery Office official charged with the duty of obtaining accurate estimates of the number of ration books that would be needed: " . . . after three and a half years your local people can, if they will use the brains God gave them and the tax-payer is paying for, make far closer estimates than they have yet done".

The iron men of the Stationery Office—with their back-breaking requirement of six months for printing a new ration book—and the registrar-general, perennially preoccupied with the needs of the National Register, emerge indeed from Mr. Hammond's narrative as firmer and somehow more professional figures

than the somewhat shadowy officials in the fluctuating divisions of the Ministry itself. Sir Sylvanus Vivian, director of registration in the First World War and registrar-general in the Second, was, in any event, one suspects, too big a man altogether to have been kept out of the centre of this picture either by Mr. Hammond or by successive generations of food rationers. His brief but compelling memorandum on a unit system of general rationing, which is printed here as an appendix and appears in essence to have anticipated the 'points' rationing system by something like a quarter of a century, reveals an imaginative grasp and a generalizing ability which, for one reason or another, were not often apparent in the schemes that followed. Those concerned with the thankless task of drawing lessons for use in the hypothetical next war might do worse than take a glance at it, if not for its matter, then for its manner. It is scarcely longer than this review.

FRANK DUNNILL

NUCLEAR MOMENTS

Kernmomente

Von Dr. Hans Kopfermann. Zweite, neubearbeitete Auflage. Pp. xvi+463. (Frankfurt am Main: Akademische Verlagsgesellschaft M.B.H., 1956.) 54 D. marks.

IN this second edition Dr. Hans Kopfermann has completely rewritten and greatly expanded his original book, which for fifteen years stood as a standard work in the field of optical hyperfine structure. During that time the moments of atomic nuclei in the ground state have been studied in many laboratories by the methods of high-frequency spectroscopy, which are here described in addition to the optical methods.

The first three sections of the book deal with the investigation of nuclear moments through their interactions in free atoms, free molecules and condensed phases, respectively. The fourth section gives an account of various nuclear models and compares the moments which they predict with experimental values.

The book is essentially a manual for experimenters. Thus, accounts are given of techniques in high-resolution optical spectroscopy, and in work on atomic- and molecular-beam magnetic and electric resonance, nuclear magnetic and electric quadrupole resonance, and paramagnetic resonance. The methods are well illustrated with examples. The theory is given in detail, both of the various techniques and of the relations between the observed quantities and the nuclear moments themselves. References to original papers number about four hundred. Tables are given of various correction factors, and of the moments of nuclei, their structure according to the shell model, etc.

The contents of this book reflect the wide range of activities in the laboratory which Dr. Kopfermann directs. His experience in these diverse fields enables him to give a first-hand and a balanced account of these branches of nuclear physics. Specialists will welcome the new edition as a reference book for use in their particular fields and as a text-book for instruction in kindred topics.

A consequence of the close association in the text of basic theory with the technique in which it is applied is a certain lack of continuity in the theoretical sections. I would have preferred to find the theory of the hyperfine structure of free atoms in one place, for example, rather than distributed between an introduction, a section on optical hyperfine structure and a section on atomic beam investigations. A further minor criticism is that references are not given to the sources of some of the reported measurements. These are small matters weighed against the vast amount of organized material in this book. Readers who have difficulty with the German text will welcome the English translation which is shortly to be published.

G. W. SERIES

MAGIC OF THE EAST

Oriental Magic

By Sayed Idries Shah. Pp. xviii+206+5 plates. (London: Rider and Company, 1956.) 25*s.* net.

IN this work the author has attempted to correlate the magical traditions of the East with those current in the West and to show how oriental influence was potent in moulding not only the lore of Western sorcerers but also the technique through which they claimed to produce their results. Possessed, as he is, with some ethnological training, Idries Shah is naturally interested in the similarities between beliefs and practices in different parts of the world; and thus he has made a special study of the evidence for the diffusion of culture, paying particular attention, as Blau had previously done, to the history of Egyptian magic and to that of Babylonia and Assyria. This book, therefore, supplies the general reader with a useful guide to the magic of the East and the importance that it must have in any appraisal of occidental sorcery.

For the purposes of the scholar, however, the book is somewhat disappointing. The author has tried to do too much in too little space, and thus much of the material is badly co-ordinated and ill-digested. In many passages he shows that he is fully aware of the difficulty of knowing what value can be placed on literary accounts of oriental miracles; yet when he has established contact with a Hindu magician who shows him striking phenomena, he does not attempt any serious investigation but takes refuge in vague suggestions of 'snap-hypnosis'. Anecdote takes the place of the kind of record we should expect from a trained ethnologist, and this is all the more regrettable since Idries Shah appears to have enjoyed opportunities for inquiry which are far from common. Nevertheless, the author stresses a point of view of which too little has been heard in the past. He points out how parapsychology, and, above all, the modern work on extra-sensory perception, are throwing fresh light into the dim recesses of the sorcerer's cave. Amid all the charms, the mumbo-jumbo and the hocus-pocus there may sometimes have emerged flashes of paranormal perception or even stranger things. It is here that, as the author says, the true link can be found which connects the sorcery of all ages and peoples, be they oriental or occidental.

The book is well produced and the list of authorities convenient for reference. It is surprising, however, that, although there are two references to the famous "Book of Changes", there is no discussion of the modern use of the technique in its relation to theories of psycho-kinesis.

E. J. DINGWALL

Manual of Elementary Practical Chemistry

By Dr. R. D. Brown and Dr. T. A. O'Donnell. Pp. ix+185. (Melbourne: Melbourne University Press; London: Cambridge University Press, 1955.) 30*s*. net.

THE practical work dealt with in this book is that arranged for first-year students at the University of Melbourne. The syllabus consists of familiar gravimetric and volumetric determinations, qualitative analysis, including the identification of cations occurring in the same group, the purification of substances, and the preparation and analysis of some typical organic compounds. In both the organic and inorganic analysis semi-micro methods are exclusively used. There are no inorganic preparations and no exercises in physical chemistry. The scheme of work, therefore, does not quite meet the requirements of Intermediate examinations in Britain. The syllabus is intended to be worked in conjunction with a course of lectures on the relevant physical chemistry.

An uncommon feature is the singular use of the Brönsted–Lowry concept of acid throughout the book. This theory is first clearly expounded and then, in due course, applied to the work in hand: that is, to neutralization and redox reactions, solvated and complex ions, the calculation of pH, the construction of titration curves, indicator action and solubility-product phenomena. The scope of the practical work is not extensive, but what is done is integrated with the theory and done thoroughly. Thus preparations and determinations are limited to typical examples, and mixtures for analysis are deliberately restricted in difficulty. The idea, a sound one, is to avoid confusing a student with overmuch technical detail, so that he may be encouraged to devote his energy to the mastery of the underlying principles.

Students using this book on such a course should emerge with an understanding of elementary analysis well calculated to help them make rapid progress with more advanced work. G. FOWLES

Treatise on Inorganic Chemistry

By Prof. H. Remy. Vol. 1: Introduction and Main Groups of the Periodic Table. (Translated by Prof. J. S. Anderson. Edited by Prof. J. Kleinberg.) Pp. xxi+866. (Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd., 1956.) 105*s*.

THIS English version of a successful German work, with modifications and improvements by the translator, has many good features. It is based on the periodic system and has chapters on many aspects of theoretical and physical chemistry which are essential in a proper understanding of inorganic chemistry. These include valency, crystal structure, bond types and resonance, co-ordination, and the modern theory of acids and bases. Industrial methods and uses are given. Physical properties and mineral compositions are tabulated.

The straightforward treatment of inorganic chemistry is generally good, but is uneven: some topics (for example, the peroxycarbonates) are dealt with superficially and not always in accord with modern knowledge, while others (for example, the lower oxides of iodine) are not even mentioned. Perhaps these latter will be included in the second volume. The modern view of the composition of bleaching powder is not given. A few minor errors were noticed: for example, S_2O_3 is green, not blue, and the melting point of ClO_2 is $-59°$, not $-76°$. References to literature are given in the text and short bibliographies at the ends of chapters.

This is a valuable and important book, which can be recommended for study and reference.

Topological Dynamics

By Prof. Walter Helbig Gottschalk and Prof. Gustav Arnold Hedlund. (American Mathematical Society Colloquium Publications, Vol. 36.) Pp. vii+151. (Providence, R.I.: American Mathematical Society, 1955.) 5.10 dollars.

TOPOLOGICAL dynamics might claim to have its roots in the dynamical astronomy of the late eighteenth century; but its present developments spring from the qualitative, topological methods introduced by Poincaré to replace quantitative methods of tackling some of the intractable problems of celestial mechanics. A further major contribution was made by G. D. Birkhoff in his systematic study of topological methods in dynamics. The subject has now become a branch of topology, wherein are studied those topological properties of transformation groups which can trace their origin back to problems in classical dynamics. References to orbits, periodicity, flows, all used in highly technical senses, only faintly recall the dynamical origins.

Profs. W. H. Gottschalk and G. A. Hedlund have organized their material admirably, so that definitions, axioms, notations and proofs are clearly identifiable, and arguments are efficient and precise. But so concise a treatment of so austerely abstract a topic has made the book difficult to read, and in order to keep the volume within reasonable compass, some knowledge of set theory and of topological groups is assumed; in fact, the relevant parts of Bourbaki should first be mastered. It is thus a book for the expert, not the novice. T. A. A. BROADBENT

What Flowering Tree Is That?

A Handbook for the Tropics. By Edwin A. Menninger. Pp. 110+4 plates. (Stuart, Florida: Edwin A. Menninger, 1956.) Cloth, 3 dollars; Paper (without colour plates), 1.50 dollars.

FLORIDA has the good fortune to possess a climate and a variety of soils ideally suited for the cultivation of flowering tropical trees. She has also produced a refreshingly original and enterprising person in the author and publisher of this little book, which describes a thousand such trees now growing in his garden at Stuart, where he keeps open house on Sunday afternoons. For many years he has imported seed of unusual and showy trees and shrubs from every tropical country in the world, and now 'The Flowering Tree Man', as he is called, hopes that other residents of Florida, the 'State of Flowers', will follow the example set by his initiative.

The trees are arranged by families in alphabetical sequence, and the common name is given precedence, followed by the Latin name and a short informal description. A few spectacular vines are listed separately at the end of the book, which is illustrated by many small black-and-white photographs and a few full-page plates in 'Kodachrome'. The botanical names are not of importance to the author, though he claims they are correct: "I don't care what you call these trees; my sole interest lies in the beauty they can produce". His enthusiasm is infectious, and the Sunday callers may be envied their unique experience with the author and his book as their guide. N. Y. SANDWITH

GENERAL ASPECTS OF AUTOMATION

A JOINT meeting at Sheffield of Sections F (Economics) and G (Engineering) of the British Association, held on September 3 and 4, discussed various aspects of automation. Under the chairmanship of Mr. A. C. Hartley, president of Section G, Lord Halsbury introduced the subject by saying that the public is substantially misinformed about it. He emphasized that it is virtually impossible to define automation and that different people define it in quite different ways. In discussion at the end of the meeting, he pointed out that in the three papers by Mr. J. F. Coales, Prof. H. D. Dickinson and Mr. George Doughty, the word 'automation' could have been substituted, without affecting the meaning, if it had been replaced respectively by some such term as increased mechanization, improved productivity or production engineering. He pointed out that the advent of automation as some new technical invention is in effect a rumour which has been taken up by the Press and become emotional rather than factual. "The automatic factory and the automatic office," he said, "have arrived, but they are no more than the development of improvements in production that have been going on for many years. The only really new technique which has been injected into industry is the digital computer." He said that automation is most likely to affect the section of industry which produces what are called consumer durables, that is, motor-cars, radio, television, washing machines, etc. It is very unlikely to be widely used in heavy engineering, shipbuilding, agriculture, mining, textiles and highly mechanized industries. Unfortunately, consumer durables are the first to be hit when there is any form of financial stringency, since when times are bad it is these goods which families first go without, making the motor-car or radio or washing machine do another few years, rather than spending less on food or on amusement. He believes that although automation will cause men and women to change their jobs and perhaps move to new areas, widespread unemployment is not a danger because in any event changes are unlikely to come about quickly.

Lord Halsbury was followed by Mr. J. F. Coales, of the Engineering Laboratory, University of Cambridge, who read a paper entitled "The Historic and Scientific Background of Automation".

"Automation", he said, "is no more than the evolution of improved methods of replacing human and animal labour by energy from natural sources and the development of tools to control these processes in order to relieve the operators of the burden of watching them or of making calculations and adjustments." This process, stimulated by man's inherent laziness, has been going on for at least two thousand years, first by the use of gravity, water- and wind-power, and later by the use of solid fuels, and now by the use of nuclear power. This has resulted in electrical energy now costing only about one five-hundredth of that of human labour, so that there is an enormous incentive to replace human labour by natural energy wherever possible; this has resulted in very rapid advances during the past few years. Water trip-hammers are known to have been in use in 350 B.C., and water-wheels existed in China, Persia and the West in the first century B.C. The prototype of the automatic factory is undoubtedly the windmill, since by the end of the eighteenth century there were many thousands in Britain, incorporating automatic controls so that they could be completely operated and controlled by one man, who could leave the mill to run untended while he dressed the stones not in use, tested the quality of the meal, or hoisted sacks to fill the automatic hoppers in just the same way as maintenance, quality control and transport have to be carried out to-day.

Mr. Coales then recounted the developments which took place in the textile industry during the eighteenth century and the development of calculating machines which started with that of Blaise Pascal in 1642. Pascal was followed by Liebniz, who designed what was the precursor of the modern desk calculator, while Charles Babbage proposed a 'difference engine' in 1822 which was the precursor of the modern digital computer. These developments led up to the automatic office, which is now an accepted fact.

Automatic production methods were then discussed, and Mr. Coales outlined the development of automatic transfer machines for the motor industry. This led on to the organization of the automatic factory of the future and developments which will be necessary to bring such a project to a successful conclusion. Most of the operations required can now be carried out automatically, although automatic assembly and automatic inspection and test present considerable difficulties. There is still, however, a long way to go from having the techniques available to being able to set up such a factory as an economic success.

Mr. Coales then discussed the effect of automation on labour; for this purpose he classified human activity under the following eight headings: (1) manual labour; (2) watching and controlling; (3) memory; (4) calculation and correlation; (5) writing and giving orders; (6) decision making; (7) research and invention; (8) design of product and plant.

Of these, the first five, it has been shown, can be replaced by machines already existing or under development; but at present it is not envisaged that there is any possibility of machines usurping the higher attributes of man inherent in the last three categories, although computing machines are making it easier for him to marshal the facts on which to make decisions and to carry out the calculations required in research and invention and in the design of product and plant. He is, therefore, being released by automation from the part he has played as a beast of burden. The challenge of automation is for us to show that by education we can train a large proportion of our manual workers to take their place in the army of skilled maintenance engineers that will be required, and eventually to swell the ranks of qualified engineers and managers who must provide the creative thought. Experience shows that the more a factory becomes automatic, the more the labour has to be transferred from the unskilled to the skilled classes, and that also there is an ever-increasing demand for the professional engineers to design new products and plant. In considering whether the automatic factory is likely to bring serious unemployment, it is important

to remember that the capital expenditure involved in setting up any automatic factory is enormous—many times that for a conventional factory—and it is quite impossible that the change-over in industry as a whole can be rapid. It is also worth noting that in the United States, manufacturing industry employs only 25 per cent of the total labour force, and clearly, not all industries are suitable for automation. Some redundancy may occur in other industries, such as banks and insurance offices, where clerks may be replaced by computing machines; but on the other hand, increased production due to automatic factories will inevitably increase the numbers required in the distributive trades.

In the second session of the morning, under the chairmanship of Prof. Gilbert Walker, president of Section F, Prof. H. D. Dickinson, of the University of Bristol, read a paper on the "Economic Effects of Automation". He said that long-period results of automation may be expected to be almost wholly for the benefit of mankind, since it will in the long run enable the joint efforts of human beings to produce more material goods with less expenditure of time and effort than before. Certain very long-term considerations do, however, obtrude themselves, namely, problems arising out of the use of leisure, the sufficiency of supplies of natural raw materials and very long-run consequences of population growth; but these he is confident can be solved by a robust application of scientific technique and a rational attitude towards problems of human ecology. He believes that the best way of ensuring the good effect of automation is by price reduction; but unfortunately, in Britain, both management and labour seem to be averse to this method. Organized labour thinks first of obtaining as much benefit as possible for the workers in the form of higher wages and shorter hours, or both, and management seems to think of price reduction as something almost indecent. To obtain the full advantages of automation, workers must be willing to change jobs and re-train for new jobs. Emphasis on traditional demarcations and rules must go. We must avoid a situation, too, where the benefits are monopolized by a small rich class giving Babylonian luxury to the few, which would give rise to a politically irresistible demand for higher taxation and nationalization of industries subject to automation. If this can be avoided, the benefits would be widely spread and there would be a big increase in services rendered to the community generally, such as those of teachers, medical men, dentists and nurses. "Automation", he said, "involves changes in the relative intensity of demand for the various agents of production. As between capital and labour, it is likely to increase the demand for capital relative to that for labour, and as between the different grades of labour it is likely to increase the demand for the highest grades of skill and reduce the demand relatively for practically all other grades. This raises an important political and social question, since in the biggest Trade Unions the numerical strength is now in the unskilled and semi-skilled grades, which are therefore likely to react violently against any tendency to put into reverse the egalitarian tendency in the movement of earned income that has shown itself so strongly during the last fifteen years. There is a danger in the tendency towards increased inequality between workers in different industries or between employees of different firms, which would be intensified by any general introduction of profit-sharing or co-partnership schemes, or even of a guaranteed annual wage on the model now popular in the U.S.A."

Following Prof. Dickinson, the large audience was delighted by a short, but excellent, contribution from Mr. George Doughty, general secretary of the Association of Engineering and Ship-Building Draughtsmen. He said that among skilled workers, automation is generally understood to offer no immediate threat to security, and is a challenge which leads to new opportunities; but he said many unskilled workers are not happy about it. "British workers," he said, "do not resist technological advances, but they resist being fired without reasonable alternative employment." He urged managements to consult work-people about changes in methods of production and to seek their co-operation. This would involve receiving suggestions, intelligently discussing alternative jobs, formally assessing compensation and discussing plans for re-training displaced workers for whom new jobs cannot be created. Some redundancy would be inevitable and planning is essential to retain maximum employment. The workers would argue vigorously for this to be tackled by shorter working hours, longer holidays and earlier retirement. "Consultations," he said, "should not be merely a formal intimation by the management of the dismissal of large numbers of work-people."

The meeting was then thrown open to general discussion, and one speaker raised the question of the possible shortage of raw materials if automation became general. He was followed by Mr. E. A. Watson, chief engineer of Joseph Lucas, Ltd., who referred to the common belief that mass-production and automation result in a product of poorer quality. He said that in every case with which he had been associated, increased mechanization or automation had resulted in a marked improvement in the quality of the finished product.

On the following morning, September 4, a number of specialist papers on automation were presented to Section G, under the chairmanship of Prof. A. L. Cullen, of the Electrical Engineering Department, University of Sheffield. In the first of these, Mr. A. J. Young, of Imperial Chemical Industries, Ltd., discussed the importance of automatic control in the process industries and gave a general description of the methods used at present. He gave a discourse on the fundamental principles underlying process control and indicated what would probably be the future developments.

Mr. D. T. N. Williamson, of Ferranti, Ltd., then presented a paper entitled "Computer-controlled Machine Tools". He said that the concept of high-speed digital computers allied to servo-mechanisms with accurate feed-back systems offers tremendous possibilities for improvement in the field of industrial controls. Although automatic machine tools have been in use for at least thirty years, they have not been applicable to the production of small quantities of complicated parts, owing to the length of time required to design, make and instal the necessary cams. However, the application of digital computer and feed-back servo-mechanism techniques to machine tools have enabled universal machine tools to be created which give fully automatic production with the equivalent of setting time, now called programming time, reduced on the average to less than one-fifth of the time necessary to make one component by hand. The computer can, at very high speed, accept basic dimensional and machining information in numerical form which often allows much of the

detailed drawing procedure to be omitted. The computer then calculates the movement of the cutting tool to machine the component and records the information on magnetic tape. A control unit associated with the machine tool into the reader of which this tape is placed controls servo-mechanisms, which move the slides in accordance with the instructions on the tape. Dr. Williamson said that the possible uses of a control system of this type go far beyond the limited field of machine tools, and the principle is applicable to all industrial processes.

The next paper, presented by Dr. Denis Taylor, of the Atomic Energy Research Establishment, Harwell, was entitled "Atomic Energy and Automation". Dr. Taylor said that automation has a large part to play in the development of atomic energy for two reasons. First, there are those processes which arise in any industry which, although they can be carried out manually, can be carried out on a large scale more satisfactorily by automatic machinery; and secondly, there are processes peculiar to atomic energy which, because of the radiation hazards, are difficult or impossible to carry out manually. Dr. Taylor described various automatic equipments used in the laboratories for reducing the amount of assistant labour that would otherwise be required for carrying out routine measurements. Such machines are capable of working night and day with very little attention and quickly pay for themselves. Automation also finds application in the atomic-energy field in the processing of experimental data, such as in the study of cosmic-ray showers. A common experiment is the observation of the coincidence-rate of two counters as a function of their separation, and this may be extended to include the coincidence-rate of three or more counters as a function of the size of the geometrical configuration, triangle or square, etc. An enormous amount of data will be obtained in quite a short time, and some form of automatic processing of the data becomes essential. In the atomic-energy field, as in the chemical industry, there has been a change-over from batch processing to continuous flow techniques, and automatic control for plants processing radioactive materials is particularly attractive because of the health hazard. Another problem which arises is that of handling the reactor fuel elements. After a nuclear reactor has been in operation for some time, re-cycling of active fuel elements may be required in order to re-use the elements. These elements will be highly radioactive and could not be handled directly. Here, therefore, there is an important problem in the field of automation.

The next and last paper, "Conscious Machines", was presented by Mr. J. Sargrove, who, as early as 1948, set up an automatic line in Britain for making radio receivers. Mr. Sargrove spoke mainly of automatic machines for inspecting and controlling the production of a number of small and common commodities. He showed a film to illustrate different types of electronic problems which occur in industry, starting with a very simple application and leading up to more complex ones, as follows: (1) automatic electronic stock-keeping; (2) automatic printing of calendars; (3) automatic production of continuous stationery; (4) automatic processing of knitted 'Nylon'; (5) automatic extrusion of plastic rods, such as knitting needles; (6) high-speed weighing of pieces of dough, and automatic control of a dough divider in a bakery; (7) high-speed counting, batching and packaging of tablets in the pharmaceutical industry.

Having given these examples, Mr. Sargrove went on to say that if we are genuinely to increase our standard of living with full employment, this can only happen by an increase in the total production of goods and commodities. If all human beings are fully employed, this extra output, which we all desire, can only come from the more intensive use of automation. In his experience, no employee has ever been discharged from a firm due directly to the introduction of automatic machines.

THE CHROMOSOMES OF MAN

By Dr. C. E. FORD and J. L. HAMERTON

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ACCURATE knowledge of the number of chromosomes and of their behaviour in mitosis and meiosis has illuminated the genetic analysis of many species. The outstanding example, of course, is *Drosophila melanogaster*[1]. *Zea mais*[2] and *Oenothera lamarckiana*[3] are notable examples from the plant kingdom. Chromosome observations have been of some value even in the fungus *Neurospora crassa*[4], and recent work[5] has given promise that the genetics of the house mouse may benefit in the same way. There is therefore good reason for supposing that the genetic study of man himself may be advanced by reliable information about his chromosomes. The unique features of the human genetic milieu—the alterati ns in breeding structure[6], the changing selection pressures[7], and the possible influence upon mutation-rates of the environmental changes of the past two or three centuries—are all in great need of study and measurement in order to be able to estimate their effect upon the genetic structure of future human populations, and it is possible that a thorough examination of the chromosomes in a range of human groups would make a useful contribution. The rapid and economical technical methods now available would enable relatively large numbers of individuals to be examined and should make a new approach to human cytogenetics both possible and rewarding. Nor is this the only field in which chromosome observations may be of value to human biology. The rapid pace at which knowledge of the chromosomes in tumours of experimental animals[8] is advancing suggests that the chromosomes may have an increased part to play in the investigation of human neoplastic conditions; and they may also be able to assist in the causal analysis of infertility, at least in the male[9].

The first attempt to determine the number of chromosomes in human cells would appear to have

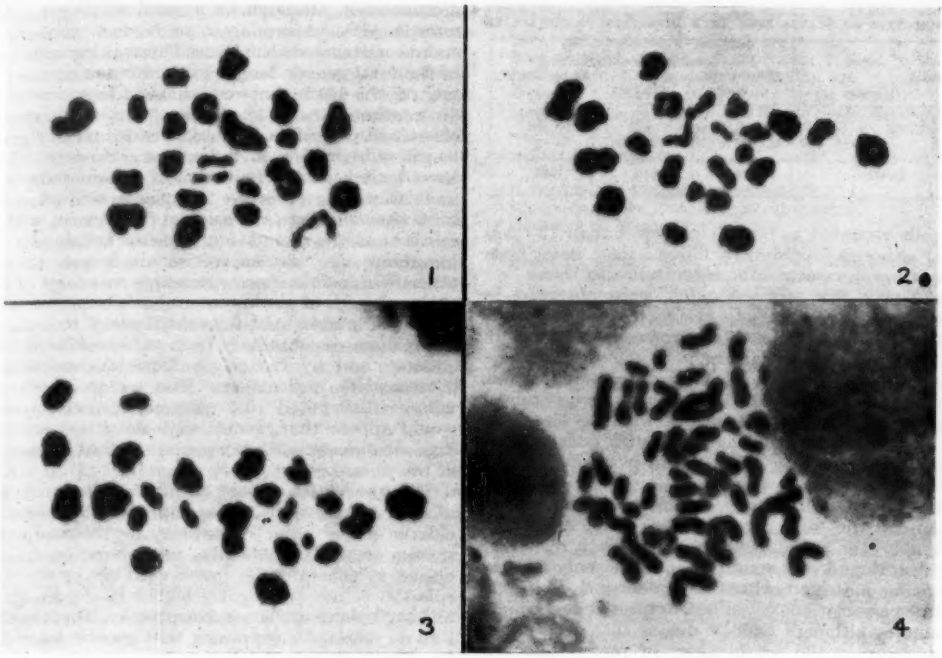

Fig. 1. First spermatocyte of patient 1 at diakinesis, 23 bivalents
Fig. 2. First spermatocyte of patient 3 at diakinesis, 23 bivalents
Fig. 3. First spermatocyte of patient 2, 22 bivalents plus univalent *X*- and *Y*-chromosomes
Fig. 4. Spermatogonial metaphase of patient 1, 46 chromosomes
All × 2,800

been made by Hansemann, who in 1891 reported three cells from 'normal human tissues' with 18, 24, and more than 40 chromosomes, respectively[10]. From then until the appearance of de Winiwarter's classical paper[11] in 1912, diploid numbers ranging from 16 to 36 were reported, the balance of opinion being in favour of 24. De Winiwarter claimed that there were 47 chromosomes at metaphase in spermatogonia, and 23 autosomal bivalents plus an unpaired *X* in primary spermatocytes. Painter[12] in 1921 reported the presence of a small *Y* chromosome in males and was the first to assert that the correct diploid number was 48 in both sexes[13]. In the following two decades most authors[14] supported Painter's position; but de Winiwarter and his associates[15] adhered to the opinion that there was only a single sex-chromosome at meiosis in the male and 47 chromosomes in spermatogonia. Koller's account[16] of the behaviour of the sex-chromosomes in spermatocyte meiosis brought this period to an end just before the outbreak of the Second World War. From then on, the value of $2n = 48$ in both male and female remained unchallenged for nearly twenty years, and it seemed that the chromosome number of man had finally been established. However, in a very recent paper[17], Tjio and Levan report consistent counts of $2n = 46$ in cultures of lung tissue taken from four aborted embryos, and refer to further counts of $2n = 46$ obtained by Hansen–Melander, Melander and Kullander in preparations of liver, also from aborted embryos. The regular loss of two chromosomes during development of the organs or growth of the cultures would seem to be most unlikely, and the implication was clear that the generally accepted figure of $2n = 48$ might, after all, have been in error.

A re-examination of spermatocyte and spermatogonial chromosomes was obviously desirable, and we have been fortunate in securing testis tissue from three males, aged forty-seven, fifty-three, and sixty-three years respectively. The material was obtained at the Churchill Hospital, Oxford, from fresh operative specimens at the moment of removal from the body. The tubules were teased out in hypotonic fluid, allowed to remain in the fluid for 30 min. at room temperature, fixed in acetic alcohol and stained by the Feulgen procedure. Squash preparations were made in the usual way. Many of them contained one or more small clusters of spermatocytes in the most suitable stages for counting, namely, diakinesis and first metaphase. Obviously broken cells with scattered chromosomes, and cells in which the chromosomes were clumped or badly fixed, were rejected. Counts were made on all the remainder and are summarized in Table 1. It will be seen that the great majority contained 23 bivalents, and that our results therefore complement those of Tjio and Levan. Examples of these cells are shown in Figs. 1 and 2. In a few cells at late diakinesis and first metaphase, the *X*- and *Y*-chromosomes were unpaired and usually well separated from each other, so that 24 bodies were counted (Fig. 3). Precocious disjunction (already reported by Koller[16] in sectioned material) would seem to be the most likely explanation of the non-association of *X* and *Y* in these exceptional cells, although some cases may have been due to the rupture of the terminal connexion between them during the making of the preparations. The

Table 1. Counts of Numbers of Bodies present in First Spermatocytes at Stages from Late Diplotene to Metaphase

Patient	Age	First spermatocytes containing: 22 bivalents or fewer	23 bivalents	22 bivalents + X + Y
1	63	9	81	11
2	53	3	39	11
3	47	2	29	3
Total		14	149	25

few cells recorded as containing fewer than 23 bivalents, although apparently intact, may have been damaged and we attach no significance to them.

Relatively few spermatogonia were observed in mitosis and, in contrast to the spermatocytes, most of them were broken and their chromosomes scattered. We have noticed similar fragility of spermatogonia in several other species of mammals. Nevertheless, a few clear counts of 46 chromosomes were obtained in apparently intact cells, one of which is shown in Fig. 4. It is noteworthy that the centric constrictions are sometimes greatly elongated in from one to four chromosomes.

In the great majority of first spermatocytes examined, the sex chromosomes were associated terminally, the attachment varying from a relatively long thin thread to a condition in which only a slight narrowing indicated where X ended and Y began. All these associations could be interpreted as terminal chiasmata, although Sachs[18] denies that true chiasmata occur in the sex-bivalent of man. The few cells in which the sex-chromosomes were present as univalents have been mentioned. In one cell only the X- and Y-chromosomes appeared to be associated in a different manner. The structure of this bivalent was not resolved with certainty; but its appearance strongly suggested the presence of a sub-terminal chiasma, or possibly that it was a 'symmetrical' sex-bivalent as described by Koller[16]. This single observation can scarcely be construed as support for the possibility of crossing over between X and Y: on the other hand, the observations as a whole are certainly not inconsistent with the occurrence of partial sex-linkage[19].

Koller[16] figured diplotene bivalents with many chiasmata. This observation we confirm. The largest autosomal bivalent frequently has five chiasmata; and some of the others may have four. In well-fixed cells the successive loops can be clearly seen in planes at right angles to each other, as in the classical plant and orthopteran species. In cells where the bivalents are rather crowded, it would not be difficult to mistake a terminal loop for an additional small bivalent. The numbers of chiasmata were counted in some of the clearest cells at stages from late diplotene to mid-diakinesis, and the results are given in Table 2.

Since the hypothesis that each cytological chiasma represents a single genetic cross-over was first put forward, evidence in its favour has been steadily accumulated, although its general validity has been questioned[20]. Assuming it to be true in man, the counts of chiasmata can be used for making an estimate of the total genetic length of the human chromosome set, on the basis that one chiasma is equivalent to 50 centimorgans. The over-all mean number of chiasmata per cell is 55·9 and the estimate of genetic length is, therefore, 27·9 morgans. However, should there have been any reduction of chiasmata by terminalization, the observed frequencies will have been *somewhat less than the original frequencies*, with the result that the estimate of genetic length will be a minimum one. So far as we are aware, the only other mammalian species in which estimates of total genetic length of chromosomes have been obtained is the house mouse, and it is satisfactory to note that the estimates obtained from Slizynski's chiasma counts[21] and by Carter's linkage-data method are in reasonable agreement. The two methods yield values of 19·2 and 16·2 morgans respectively[22]. It would appear that, genetically, the chromosomes of man are at least half as long again as the chromosomes of the mouse.

Table 2. Counts of Chiasmata at Stages from Late Diplotene to Mid-diakinesis

Patient	Age	Cells counted	Chiasmata per cell: Range	Mean
1	63	11	50–62	54·4
2	53	6	52–62	57·1
3	47	6	50–63	57·1
Total		23	50–63	55·9

The reservation should be made that the estimate of 27·9 morgans strictly applies to middle-aged and elderly males only. However, in the mammalian species studied genetically, recombination fractions do not in general differ much with age or sex. As a rule the values are slightly higher in the female sex, although there are some exceptions. There is therefore no reason for supposing that genetic lengths will be greatly different in the two human sexes, and until direct estimates have been obtained at oogenesis the value of 27·9 morgans derived from chiasma counts at male meiosis may be regarded as an approximate minimum estimate for the female also.

Two comments in connexion with the high frequency of occurrence of chiasmata are relevant: it reflects the rarity with which autosomal linkages have been detected in man; and it implies a genetic system in which there is a rapid re-assortment of the genotypic variability, which, according to Darlington[23], is the mark of a plastic species able to adapt itself readily to diverse environmental circumstances.

Returning to the question of the chromosome number of man, how should the discrepancy between the recent counts and the older ones be explained? Although the occurrence of numerical chromosomal polymorphism has now been established within populations of one mammalian species[24] and may exist in a second[25], it is most unlikely that the occurrence of a similar situation in the human species could provide the whole answer—the probability of drawing by chance from such a polymorphic population seven successive individuals (four of Tjio and Levan, three recorded here) with 46 somatic chromosomes after an even larger series all with 47 or 48 would be altogether too low. Nevertheless, the rare occurrence of individuals with the latter numbers is not excluded. The alternative is to assume a persistent error, and this we consider to be the more likely explanation. (It is of interest to note that in his preliminary communication on the subject, Painter was uncertain whether the diploid number was 46 or 48.) Three features of the behaviour of human chromosomes which have already been mentioned may have contributed to erroneous counting. In somatic cells and spermatogonia, one or more of the exceptionally long centric constrictions seen in some chromosomes may have been overlooked, with the result that each arm was counted as a separate

chromosome; and in spermatocytes, counts of 24 bodies could have arisen as a consequence of precocious disjunction of *X*- and *Y*-chromosomes, or from mistaking an end loop of one of the larger elements for a separate bivalent. In view of the much closer packing of the chromosomes in the cells, these difficulties would have been much more serious with the older sectioning technique. Undoubtedly the adoption of the squash method[25] and ancillary treatments for dispersing the chromosomes within the cells[27] is bringing about a great change in mammalian chromosomal cytology, and it is to this technical improvement that the rectification of the error—if such it be—must primarily be attributed. The crux lies no longer in the microscopy but in the preparative technique. The weary hours of toil which the pioneers must have spent at the microscope is reflected in de Winiwarter's *cri de coeur*, "J'ai perdu un temps énorme à répéter des numérations fatigantes et j'avoue aussi, très fastidieuses". The wonder is that there is so little to alter.

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PROPERTIES OF MAGNETIC MATERIALS

THE final session of Section A (Physics) of the British Association was held on September 5, and appropriately for a Sheffield meeting was devoted to three papers dealing with various aspects of magnetism.

Prof. W. Sucksmith, of the Department of Physics, University of Sheffield, gave an outline of the developments leading to present-day production of magnetically hard materials for permanent magnets and magnetically soft materials for use in dynamos, transformers and other electromagnetic devices. The desirable characteristics of the two types of material are respectively high coercivity and high permeability. Until the early years of the twentieth century, tool steel was used in the manufacture of permanent magnets and no special materials were produced for the purpose. Subsequent empirical development culminated in the production of oxide magnets (cobalt ferrite, $CoO.Fe_2O_3$) by Kato and the iron–aluminium–nickel magnet steel, the parent of many present-day magnet steels, by Mishima.

A number of interesting problems of fundamental importance have arisen from considerations of the magnetization processes responsible for the high coercivity of permanent-magnet materials. Modern theories of magnetization processes are based on refinements of the theory of magnetic domains originally proposed by Weiss. In general, it is supposed that ferromagnetics are subdivided into domains in each of which the elementary magnetization vectors lie along one of two or more preferred directions; domains characterized by different preferred directions are separated by domain boundary walls. In the demagnetized state the domain arrangement is such as to produce zero external magnetization. However, when a magnetic field is applied the domain walls move, domain magnetization vectors rotate from the preferred directions and the specimen becomes magnetized. Materials in which domain boundary movements are greatly impeded by structural and other imperfections are magnetically hard and have applications as permanent magnets. Néel, in his theory of 'disperse fields', has considered these aspects in detail. High coercivities may also be obtained in materials in which magnetization cannot occur by boundary movement but by rotation of domain magnetization vectors from one preferred axis to another. Thus if the dimensions of an isolated ferromagnetic particle are sufficiently small (~ 300 A.), it is energetically unfavourable for boundary walls to be created and the particle is a single magnetic domain. No boundary movements are involved in the magnetization of an assembly of single-domain particles; only rotations of the magnetization vectors may occur against anisotropy forces arising from the shape of the particles, crystalline anisotropy or strain anisotropy. It follows, as Néel in France and Stoner in Britain have shown, that prolate ellipsoidal particles departing by relatively small amounts from a spherical form will possess high coercivity. This work has stimulated the production of compacts of oriented single-domain particles of acicular shape for use as permanent magnets and also for magnetic recording tape.

In this connexion work on single-domain assemblies which is being carried out at Sheffield was also

mentioned. Copper–iron alloys containing about 1 per cent of iron may be rapidly quenched from high temperatures and preserve the iron in solid solution. Precipitation of the iron in fine particle form can be induced by heat treatment at lower temperatures and may be interrupted at various stages to investigate the magnetic properties. Alloys of coercivity 500 œ., but with low remanent intensity of magnetization, have been produced in this way. It has also been found possible, by cold drawing the alloys, to orient the precipitate. In this way cold-drawn alloys with precipitated iron and nickel have been prepared with coercivities of greater than 1,500 œ. and 670 œ., respectively.

The necessary characteristics of magnetically soft materials of high permeability were then considered as the converse of those possessed by permanent magnet materials. For high permeability the material must have low magneto-crystalline anisotropy and low magnetostrictive deformation in order to minimize the effect of internal strains. For example, the composition of the alloy of iron–silicon–aluminium of the highest permeability is 84 Fe, 10 Si, 6 Al; for which the values of magnetocrystalline anisotropy and magnetostrictive deformation are least.

Prof. Sucksmith's conclusions were that, so far as the conducting magnetic materials are concerned, both soft and hard materials appear to be within sight of a stage where the relevant quantities are only reached under exacting laboratory conditions. The practical applications are becoming more and more controlled by manufacturing expediency. It also appears that the rapid extension of the alternating current applications of the non-conducting magnetic materials, particularly to high frequencies, gives a promise of a greatly expanded future.

In a paper by Dr. E. W. Gorter, of the Philips Research Laboratory, Holland, some aspects of the properties and underlying theory of non-conducting magnetic materials, the ferrites, were discussed. The unit cell of a ferrite may be represented by the formula $M_8Fe_{16}O_{32}$, where M is a divalent metal; the crystal structure is cubic spinel. The metallic ions occupy two types of site in the lattice: A-sites for which there is tetrahedral co-ordination with oxygen ions, and B-sites having octahedral co-ordination. Dr. Gorter exhibited a model of part of the unit cell which convincingly illustrated the possible magnetic couplings between the ionic moments of metallic ions occupying A and B sites. In general, the ionic moments are aligned mutually parallel or antiparallel.

The characteristics usually required of ferrites in alternating-current applications are high permeability and low loss. In turn, these characteristics depend on the spontaneous magnetization of the material, I_s, the magneto-crystalline anisotropy, K, the magnetostrictive deformation, λ, and the internal stresses and defects. The latter are inevitably introduced during the sintering processes used in the manufacture of ferrites and can never be entirely eliminated by annealing. Systematic investigations of the factors which influence I_s, K and λ (chiefly by Dr. Gorter and his colleagues) now make it possible for ferrites to be 'tailor-made' and suitable for a wide variety of applications. Thus, it follows from the theory of ferrites, originally developed by Néel, that the addition of zinc leads to an increase of spontaneous magnetization. Gorter has shown that this increase is limited by the fact that, when the zinc content exceeds a certain limit, the ionic moments are no longer mutually parallel or antiparallel. This leads to a reduction of spontaneous magnetization. The total magnetic moment of a magnetic ion is the resultant of two components, one due to electron spin and the other arising from the orbital motion of the electrons. There is a direct connexion between the magnitudes of the magneto-crystalline anisotropy and the orbital contribution to the ionic moment. Thus the orbital contributions to the moments of cobalt and nickel ions are 0·3 and 0·7 Bohr magneton, respectively, and cobalt and nickel ferrites are characterized by large magneto-crystalline anisotropy. However, the magneto-crystalline anisotropy coefficients of cobalt and nickel ferrites are of opposite sign; in cobalt ferrite the directions of easy magnetization are along cube edges, whereas for nickel ferrite cube diagonals are easy directions. Thus by sintering nickel ferrite with a small quantity of cobalt ferrite, it is possible to prepare materials in which there are only small magnetocrystalline anisotropy forces impeding rotation of the magnetization vectors and the permeability is high. Materials of this type purposely made with defects and air pores are found to have a low-temperature coefficient of permeability over a range of 60° C. The magnetostriction of ferrites can also be controlled by preparing mixed ferrites. The majority of ferrites have positive magnetostrictive deformation, that is, they expand on magnetization in a direction along the applied field. However, ferrous ferrite, $FeO.Fe_2O_3$, contracts on magnetization and has a negative magnetostriction. The magnetostriction of a mixed ferrite can thus be made zero if it contains the correct proportion of ferrous ferrite.

The concluding section of Dr. Gorter's paper dealt briefly with some of his recent work on dipole–dipole interactions in ferrites. In both manganese and lithium ferrites the orbital electron contributions to the ionic moments are small, and it follows from the above that the magnetocrystalline anisotropy energies are small in both cases. At first sight it would therefore appear that the permeabilities of both lithium and manganese ferrites should be comparable. However, it is observed that the permeability of manganese ferrite (μ approximately 400) is about ten times that of lithium ferrite (μ approximately 40). The reason for this difference is revealed by studying the influence of a magnetic field applied to lithium ferrite during its cooling from high temperature; the permeability measured along the field direction drops to a value of 9. The interpretation is that in lithium ferrite there are additional forces, inhibiting the rotation of the ionic magnetization vectors, which arise from dipole–dipole interaction. When the field is applied during cooling, the interaction is between lithium ion pairs aligned along the field direction.

In sum, the paper fully justified Dr. Gorter's claim that by adopting careful manufacturing techniques and applying sound theoretical principles, it is now possible to produce ferrite materials of predictable properties and suitable for a wide range of applications.

The final paper of the session was presented by Dr. A. Edwards, of James Neill and Co. (Sheffield), Ltd. Dr. Edwards first dealt with the historical development of the Sheffield magnet steel industry. The most modern and most efficient product of this industry is an alloy prepared by special cooling techniques to have a columnar structure with crystallites having axes of easy magnetization lying

along a common direction. The composition of this alloy, known as 'Columnar', is adjusted so that valuable anisotropic magnetic properties are obtained by cooling the completed magnet in a magnetic field. It was pointed out that although the Sheffield permanent magnet tradition is based on alloy steels, it is realized by some manufacturers that future development may well be into the field of ferrite or shaped micropowder magnets. As an example of this trend in Sheffield, brief reference was made to the progress which has been made in the preparation of the anisotropic material $BaO.(Fe_2O_3)_6$; although it has been found difficult to obtain consistently high values of stored magnetic energy with this material, many production problems have recently been solved.

The second part of Dr. Edwards's paper was devoted to an account of some of the very many practical applications of permanent magnets. This was illustrated by a number of well-chosen and most efficiently presented demonstrations, all of which were greatly appreciated by the audience. Outstanding among the applications considered were the automatic train control system using permanent magnets, now installed on the King's Cross–Grantham line, and the hysteresis motors with very small permanent magnet rotors for operation at speeds of 10,000 rev./min. and above. R. STREET

PLASTIC THEORY OF STRUCTURES

CAMBRIDGE SYMPOSIUM

A RECENT book review ("Plastic Behaviour and Design of Steel Frame Buildings", *Nature*, August 4, p. 227) gave some account of the advances which have been made since the War in the theory of structures, particularly in the plastic design of steel structures. Much of this work has been carried out in the Cambridge Engineering Laboratory. It was fitting, therefore, that the first symposium on the subject in Britain should be held there. One hundred and ten engineers and applied mathematicians, nine from the United States, five from Holland and representatives from the U.S.S.R., Belgium, India and Italy watched, in the introductory session, after dinner in the hall of Clare College on September 18, experiments carried out by Prof. J. F. Baker on three steel structures loaded to collapse. These experiments showed some of the advantages of basing design on plastic behaviour.

During the next three days, eight working sessions were held. The first paper, introduced by Dr. J. Heyman, dealt with the plastic design of single-story portal frames. These have been of particular importance in the development of plastic theory, and a consideration of their behaviour forms a useful introduction to the subject. After dealing with some simple cases, Dr. Heyman turned to the multi-bay frame in which collapse is usually confined to the end bay only. If a horizontal tie is introduced at eaves-level, or the end stanchions are made so stiff that horizontal 'sway' movement is prevented, other interesting modes of collapse under unsymmetrical load and an instability mode may be introduced. Though a separate session had been set aside for the discussion of instability, the subject loomed large in this first session and not unnaturally became the recurring theme of the whole symposium. Mr. A. Bolton complained that the effect of axial load in the rafters was usually neglected and presented calculations showing that considerable reduction in load-carrying capacity would result if the rafter carried an axial load as low as one-tenth its Euler crippling load. This led to a discussion of the effect of cladding on the behaviour of shed buildings. Mr. R. L. Ketter, of Lehigh University, where a research team is working on plastic design, showed a series of curves from which could be read the sizes of members required for a wide variety of shed buildings. This approach appealed to some of the consulting engineers present.

The second paper, introduced by Dr. M. R. Horne, dealt with multi-story frames, in particular with that most complex problem, the behaviour and design of continuous stanchions. The paper considered only those frames where horizontal sway is prevented by the cladding, and showed the state of knowledge of stanchion behaviour and the resulting methods of design available at the moment: namely, to design the beams of the structure to remain elastic, allowing the stanchions to enter the plastic range, or to design the beams plastically while the stanchions are so proportioned as to remain elastic at the collapse of the beams. The discussion began with the description by a practising engineer of a method of analysis based on an assumed initial curvature which he had found confirmed by the early Cambridge tests on stanchions. This was an attempt at an empirical solution, following the kind of reasoning used to-day in elastic design; but it was decided that there is, as yet, insufficient justification for its acceptance. The discussion then turned to the dangers of sway instability, that is, the possibility of the frame as a whole becoming unstable even though the individual members had not reached full plasticity. It seemed to most of the members of the symposium that this was not a real danger for buildings of the type and height usual in Britain, but would become important if brick panel walls were replaced by the metal cladding which is becoming common in America. More attention must clearly be given to the problem as the plastic method is developed for multi-story structures. Attention was directed to the four-story wing of the Engineering Department at Cambridge now under construction and visible from the symposium room, which had been designed plastically—sway collapse fortunately being prevented by its attachment to the main building.

The third session was devoted to the subject of foundation design, with an introductory paper by K. H. Roscoe and A. N. Schofield. One of the attractions of the plastic method of designing a steel frame is that it allows a rational approach to be made also to the design of foundations. It is usually desirable, so far as the superstructure is concerned, to fix the feet of the stanchions. Orthodox elastic design virtually demands the assumption, in such a case, that the feet are completely encastré, so that no rotation or sinking can occur. It is, of course, impos-

sible to build foundations which satisfy this assumption. The plastic design of the framework is unaffected, however, by sensibly large rotations or sinking of the foundations, so long as the full plastic moment of the steel stanchion can be developed. The Cambridge team has carried out full-scale tests on steel shed buildings with real, and most economical, foundations which confirm this. Plastic theory can also be applied to the design of the foundations themselves, and it is common to assume the soil to be a dilatant perfectly plastic material. It is interesting, as indicating how far the principle of plastic design for the steelwork had been accepted by the audience, that the lively discussion was centred almost entirely on the design of the foundations. The merits of pad and pier foundations for eccentric loads were compared, together with the advantages of tieing the latter and the practical difficulties of so doing. It was remarked that when excavating the soil after failure around the pier foundations, in the tests mentioned above, a layer of loosened soil into which the fingers could be inserted was evident to a depth of 2 ft. between the moving soil wedge and the surrounding soil. The thickness of these dilatant layers was so small in any form of laboratory or model test that they could not easily be measured or even observed.

The fourth session was opened with an elegant paper by Prof. W. Prager, of Brown University, on plastic design and thermal stresses. The work was based on an idealized moment curvature relationship applied to a propped cantilever introducing also the concept of standard states of bending moments. This particular problem allows of graphical representation but leads to general theories which can be proved rigorously. It was found that shakedown would occur if, and only if, a state of self-stress could be found such that superposition of the elastic response to the prescribed cycles of load and temperature on this state of self-stress nowhere led to a violation of the yield condition. It was suggested in the paper that alternating plastic deformation must be avoided at all costs. Discussion revealed evidence that in many steels tens of thousands of cycles are necessary to produce failure under this condition, so that in many practical cases it may be unobjectionable. An incremental collapse mechanism involving large changes of geometry might, on the other hand, be objectionable. The discussion turned again to problems of instability. Attention was directed to the case of a plate subjected to lateral load where compressive stresses led to buckling. Prof. Prager remarked that compressive stresses in themselves did not upset the plastic theory, but that if buckling occurs then some modification has to be made. It was pointed out that buckling due to heating and due to loading are quite different effects and that incremental collapse cannot be produced by thermal cycles alone. Some loading of the structure is necessary for this mode of collapse, but thermal stresses alone can produce incremental buckling.

The session dealing with impact was introduced by two very different papers, "Dynamic Loading and Impact", by Prof. Paul S. Symonds, of Brown University, and "Simple Experiments on the Dynamic Plastic Behaviour of Mild Steel Beams", by Dr. E. W. Parkes, of Cambridge. Prof. Symonds has attempted to replace the structure, subjected to such impact loading as a severe blast pressure, by a model of one degree of freedom, when the structure in fact would undergo a highly complicated series of shape changes that would require many degrees of freedom in an accurate description. Dr. Parkes described experiments he has carried out to find how structures behave when struck by moving masses. He found that, except at the point of impact of a high-velocity projectile, their deformations could be predicted by analysis based on the concept of a constant dynamic plastic moment. There was much discussion on how far the elastic response of a structure could be neglected and on the influence of high rates of straining on the yield. It was pointed out that the simple plastic theory leads to a simple and most reliable design method for structures under impact when the rates of straining are not excessively high. A demonstration showed how the once familiar 'Morrison table shelter' behaved, and a film illustrated the success of an even earlier war-time application of the plastic method to the design of reinforced surface shelters. The hope was expressed that the results of the vast amount of experience obtained in Britain during the War had been made available to American workers.

While discussion on various aspects of instability kept recurring throughout the Symposium, one session was devoted entirely to the subject. W. Merchant, of the Manchester College of Technology, had provided in an introductory paper a study of the behaviour of a structure which fails by a combination of plasticity and instability, using some of the early Cambridge strut tests as an illustration; but in opening the discussion he turned immediately to the possibility of overall instability in a multi-story frame in which sway bracing of one form or another was not present. As in the second session, this gave rise to much discussion and a certain feeling of pessimism. Accounts were given by Dr. R. H. Wood of the Building Research Station and others of particular problems which have been solved exactly, the labour involved being excessive; but though Mr. Merchant suggested some interesting empirical approaches, it became clear that this is a branch of the subject which requires more study. Among other problems discussed was the lateral instability of I-beams. It appeared from Prof. B. Thurlimann's account of work at Lehigh that the broad-flanged beam is not as satisfactory in this respect as the British Standard section. Dr. M. R. Horne gave an account of how design rules have been evolved to guard against the danger of lateral instability in plastic designs using British Standard sections.

The seventh session was devoted to design problems and was opened by Dr. M. R. Horne and Dr. J. Heyman with a paper raising some of the practical problems encountered by the Cambridge team in producing the first plastically designed structures. Slides were shown of a number of these buildings, including a seventeen-bay factory building, an unusual monitor-type portal frame workshop and the British Welding Research Association's fatigue laboratory, which was the first plastic building. This encouraged others to show their designs. Mr. R. T. Cole, who has used the plastic method for some hundreds of structures, claimed that bolted connexions can be satisfactorily introduced, are attractive architecturally and are cheaper than site-welded connexions. He was challenged on this last point, as certain firms insisted on the site-welding of their structures because it gave the lowest erection costs. There was much discussion on the problem of deflexion in plastically designed structures. Engineers were urged to publish accounts of the structures they designed plastically, as only in this way can experience

be passed on quickly and the more timid encouraged to use rational methods.

The final session dealt with the teaching of the plastic theory of structures and its place in the university curriculum. Prof. J. F. Baker made it clear that, while he is enthusiastic about the subject, particularly as it is the only satisfactory way structural design can be taught in a university, he would not introduce it into the engineering syllabus unless something else could be left out. This naturally led, in the vigorous discussion which always arises when teaching problems are ventilated, to the question of what can be left out of to-day's crowded syllabus. The conclusion reached was that in an undergraduate course on theory of structures, a sound grounding in the fundamentals makes it possible to omit many of the specialist methods of elastic stress analysis. Stability again came to the fore; one experienced teacher, putting in a plea for its consideration, pointed out that he was not committed to any particular theory. He regarded all theories as tools of analysis, so that a student should be capable of dealing with problems of elasticity, plasticity and stability. Other topics discussed were the possible use of models in teaching and the behaviour of flat plates, the last arising from an illustration used by Prof. Prager to show there is no satisfactory method of elastic design.

At the end of the session Prof. Symonds, after dealing with the teaching at Brown University, remarked on the high level of interest and the high standard of discussion which had persisted throughout the three days of the symposium. Mr. T. R. Higgins, secretary of the American Society of Steel Construction, who had presided over this last session, expressed surprise at the level of familiarity with the subject shown by such a large group of practising engineers. He said that it is a new subject for American engineers, who are not so far ahead with it as are designers, in Britain.

There is no doubt of the unusual interest throughout the symposium. Plastic design, which enables so many of the unsatisfactory assumptions of elastic theory to be swept aside, has captured the imagination of most teachers and of many practising engineers. While there is little evidence that the great body of structural designers are aware of the revolution in their art, plastic design is clearly spreading fast.

OBITUARIES

Dr. J. W. Trevan, F.R.S.

Dr. J. W. TREVAN was well known as a pharmacologist and as a pioneer of the biological testing of drugs. He died on October 13 last at the age of sixty-nine. He was born in Bodmin and after education in Plymouth he gained scholarships to St. Bartholomew's Hospital, London, where he obtained several prizes and graduated in physiology in 1908 and in medicine in 1911. After undertaking resident appointments, he obtained the Fishmongers' Research Scholarship and carried out research on respiration. In 1914, he qualified as M.R.C.P. and served in the First World War as a pathologist.

Trevan joined the Wellcome Physiological Research Laboratories at Beckenham in 1920; later he became a member of the Standards Commission of the League of Nations, and was elected president of the Section of Therapeutics of the Royal Society of Medicine. In 1940 he became director of the Wellcome Physiological Research Laboratories and a director of the Wellcome Foundation, Ltd. In 1942 he became a Fellow of the Royal College of Physicians and in 1946 a Fellow of the Royal Society.

At Beckenham Trevan worked at first on local anæsthetics and analeptics, and on chemotherapy. He had great ability in the design of apparatus, and the simple and useful microbalance and microsyringe which are now very commonly employed were his inventions. Soon his attention was attracted to the difficulty of biological standardization of digitalis, and later of insulin. Up to that time, no one had realized that one animal differed very greatly from another similar animal of the same species in its response to drugs. Trevan's work emphasized the necessity for the use of a large number of animals for the standardization of drugs and he introduced the term *LD*50 for the dose of drug which would kill 50 per cent of the animals under test. Much of his work was directed to the standardization of insulin; there were great difficulties in this matter as the early batches of insulin varied considerably from one to another and clinicians were unable to depend on a constant preparation. His work resulted in the development of a very satisfactory method of standardization using a quantal method depending on the convulsions induced in batches of mice. This work provided for a test for insulin which enabled the clinician to rely on every batch being of the same potency, and it was a considerable contribution towards the solution of the problem of the treatment of diabetes.

His work on the bioassay of drugs was published in the *Proceedings of the Royal Society* in 1927; it was the forerunner of the statistical methods of drug standardization which are in common use to-day, enabling us to make an accurate assessment of the error of a particular test. These assays are of fundamental importance, both to the manufacturer of therapeutic substances and to the physician who is making use of the preparations.

Trevan was one of the most friendly and helpful of colleagues, and his great scientific ability was devoted as much to helping his associates and subordinates as to his own research. While he was a great enthusiast in all scientific matters, he was much more critical of his own work than that of his colleagues, and his notebooks contained great numbers of records of carefully controlled experiments which he did not feel were sufficiently significant for publication. He had a great sense of humour and delighted in telling stories against himself; the many honours he received he always felt were quite undeserved.

While so many workers in the field of pharmacology have gained much of his advice and foresight, such was his modesty that he usually managed to make them feel that they had thought of the ideas themselves. He was a pioneer in pharmacology, especially in the field of the standardization of drugs, and

there are many who will miss his friendly advice and help.

He was a deacon and member of the choir at St. Aubyn's Congregational Church at Upper Norwood. His first wife, daughter of the Rev. J. L. Keyes, died in 1937. Of this marriage there were three sons and two daughters. His second wife, by whom he had three children, is the daughter of Sir Hubert Llewellyn Smith.

G. A. H. Buttle

Prof. Arthur Rohn

A year ago mention was made in these pages of the first centenary of 'ETH', as it has come to be internationally known, namely, the Eidgenössische Technische Hochschule, Zurich, or the Swiss Federal Institute of Technology. Now we have to record the death on October 3 of the man who more than any other in his generation helped to give the Institute the position it holds as a centre of teaching and research in the field of technology in the widest sense of the term: Prof. Arthur Rohn, former president of the Institute's board and rector as well as a member of the professorial staff during eighteen years.

In the twenty-two years from 1926, when he was appointed head of the Institute, until 1948, when, greatly admired and respected as one of the country's élite, he gave his farewell address, Prof. Rohn had determined the policy and guided the development of the Institute in a way that earned him the gratitude of scholars, students and industrialists all over the world. His greatest achievement is the creation of more than two dozen specialized research centres in the form of institutes, which he helped to provide with sufficient grants, libraries, staff and special buildings. In addition to this, he persuaded the Swiss Government to create forty new professorial chairs in the field of pure and applied science. If the research institutes, for example, of aerodynamics, town and country planning, industrial accountancy, bear witness to his far-sighted vision, other innovations, like the new chairs for theoretical physics and mathematics, show his insistence on solid basic research in fundamentals.

Before he was called to the post of president of the Institute's Board, Prof. Rohn had held for nearly twenty years (1908–26) one of the most important chairs of civil engineering, that of structural engineering and bridge-building. Early and extensive experience in bridge-building in Switzerland and the Ruhr district had introduced him to this, his favourite field, in which he soon rose to be a master.

It was not only the eminence of the specialist nor the long experience as an academic teacher that enabled Arthur Rohn to exercise his brilliant leadership in higher professional education and industrial development, nor were these the only qualities that earned him the high respect—the veneration even—that was felt for him in later years. He combined qualities that are not often found together in such fullness: breadth of vision with practical executive power and great firmness of will, a profound belief in the capacity of men to improve things, with a clear notion of what was possible, aristocratic aloofness with kindness and generosity and a sense of justice. It was this largeness of his mind and the impressive stature of his moral character that won him the admiration of his students and that inspired the Institute of which he was for so many years the head.

Max Wildi

V. A. Obruchev

Vladimir Afanasievich Obruchev, the premier geologist in Russia, died in Moscow on June 19, at the age of ninety-three. He was born on September 28 (Old Style), 1863, in Klepinino, Tver district, in the family of an army officer. He was educated in Vilna, and went to the St. Petersburg Mining Institute. After graduating as a mining engineer in 1886, he went to Central Asia where, following the lead of his teacher, Prof. I. V. Mushketov, he spent two years in the study of aeolian deposits. In 1888 he was attached to the Mining Department in Irkutsk.

This was the beginning of Obruchev's work on the geology of Siberia, to which he devoted the rest of his life. At first he worked on the stratigraphy and tectonics of the Palæozoic and Pre-Cambrian rocks of the Transbaikal and Lena region, and studied the geology of the gold fields. In 1892 he started on a series of travels to Central Asia, Dzungaria, Mongolia, China and various parts of Siberia. For a time he taught geology in Tomsk Polytechnical Institute (1901–12) and later in Taurida University at Simpheropol (1918–22) and in the newly founded Moscow Mining Academy (1922–28). In 1929 he was elected to the Academy of Sciences and during 1929–34 he was the director of the Geological Institute of the Academy. There are many other administrative and editorial posts which he filled at different times in his career.

Obruchev's publications are very numerous and they range over a wide field. His most important work deals with the geology of Siberia, on which he was a recognized authority. The three fundamental works on this subject are: "The Geology of Siberia", in one volume (1926), published both in Russian and German ("Geologie von Siberien"); "The Geology of Siberia", in three volumes (1935–38); and "The History of the Geological Explorations of Siberia", in five volumes (1931–42). The two best-known text-books written by Obruchev are: "Ore Deposits" and "Field Geology". His travel books include: "Central Asia, Northern China and Nan-Shan", "From Kyakhta to Kuldzha", "In the Mountains and Deserts of Central Asia", and "My Travels in Siberia". But even more popular were Obruchev's novels, all of them provided with a vivid geological setting, such as "The Land of Sannikov", "Gold-seekers in the Desert", and "Plutonia".

Obruchev, in the eyes of his contemporaries, was not only a great geologist, a great traveller and a great writer; he was also a man of striking personal charm, a remarkable organizer and a great character. He was very popular, especially with the young readers of his popular books and novels; it was said of him that he used to receive thousands of letters, and that none was left unanswered when an answer was asked for.

S. I. Tomkeieff

Mr. D. L. Edwards

With the death on September 23, after a brief illness, of Mr. D. L. Edwards, director of the Norman Lockyer Observatory of the University of Exeter for nearly twenty years, another link with Sir Norman Lockyer, eminent astronomer and founder and editor for many years of *Nature*, has been severed all too soon.

Donald Luther Edwards was born at Peterborough on January 11, 1894, into a family whose scientific

attainments were later to receive distinguished recognition in the fields of entomology and geology. He was educated at Cambridge County School, and the Royal College of Science, London, whence he graduated with the associateship, and a diploma in astronomy.

On the outbreak of the First World War he joined the Signals section of the Royal Engineers, serving in France with a sound-ranging unit. After demobilization early in 1919, Edwards went to Sidmouth as assistant to Lockyer, and commenced his duties at the Hill Observatory (as it was then called) in May of that year. Sir Norman died in 1920; and with the appointment of his son, Dr. W. J. S. Lockyer, as director in February 1921, Edwards became chief assistant, which post he held until December 1936, when he, in turn, was made director following the death of Dr. Lockyer.

During the period of his association with the Lockyers, Edwards's main interest lay in the determination of stellar parallaxes by a spectroscopic method first suggested by Adams in 1920. At Sidmouth, the technique was successfully applied to objective-prism spectra; and between 1922 and 1930 six papers were published by him, summarizing the results for two hundred B-type stars.

Later researches continued the study of the irregular variable, γ Cassiopiae, begun in 1923 by W. J. S. Lockyer. Quite recently, he had contributed an essay on this star to the second of the commemorative volumes, "Vistas in Astronomy", presented to Prof. F. J. M. Stratton on his seventieth birthday.

As director, he had the future development of the Observatory always at heart, while preserving the best of the Lockyer tradition. It was due largely to his untiring efforts that the Observatory Corporation was transferred to the University of Exeter (then the University College of the South-West) in May 1948.

Edwards was elected a Fellow of the Royal Astronomical Society in 1921 and served on its Council during 1946–50; he was also a member (from 1915) of the British Astronomical Association.

In all that he undertook he was conscientious and meticulously careful in every detail. Outside his professional work, his interests were wide, embracing such diverse subjects as music, ornithology, Egyptology and philately. For almost forty years he had known the encouragement and support of a serenely happy domestic life, having married in 1919 Elsie, daughter of the late Thomas Stanley, of Wednesbury, who survives him. D. R. BARBER

NEWS and VIEWS

Chemical Engineering at the Imperial College, London: Prof. P. V. Danckwerts

A CHAIR of chemical engineering science has been established in the Department of Chemical Engineering at the Imperial College of Science and Technology, London, and Mr. P. V. Danckwerts has been recently appointed to it. Mr. Danckwerts studied chemistry at Balliol College, Oxford, under Mr. R. P. Bell. Graduating in 1939, he spent a year as a research chemist with the Fullers' Earth Union before joining the Navy. He served for six years, first as a bomb-disposal officer in various parts of the world, then, after being wounded during the invasion of Sicily, at Combined Operations Headquarters. At the end of the War he went as a Commonwealth Fund Fellow to study chemical engineering at the Massachusetts Institute of Technology, and received a master's degree in chemical engineering practice in 1948. He then joined the staff of the newly formed Department of Chemical Engineering at Cambridge, where he spent the next six years as a demonstrator and lecturer, helping to establish the curriculum and set the standards for the Chemical Engineering Tripos course. He also made a number of theoretical contributions to chemical engineering science in the fields of diffusional processes, mixing and continuous-flow systems. For the past two years he has been deputy-director of the Research and Development Branch of the Industrial Group, Atomic Energy Authority, where his duties have included the direction of the Group's extensive development work in chemistry and chemical engineering.

Senior Appointments at the Royal Aircraft Establishment: Mr. E. C. Cornford

MR. E. C. CORNFORD has been appointed head of the Guided Weapons Department of the Royal Aircraft Establishment. He was educated at Kimbolton School and Jesus College, Cambridge, where he read mathematics, graduating in 1938. He entered government service at the Royal Aircraft Establishment, where he was concerned with research on armament problems. During most of the war years he worked with the late Dr. L. B. C. Cunningham in the Air Warfare Analysis Section of the Air Ministry at Harrow. His work covered a wide range of theoretical investigations in the growing field of operational research, the application of mathematical probability methods to problems of air combat, and the introduction of the new radar blind-bombing devices which were so successfully used by Bomber Command. In 1946 he was transferred to the newly formed Controlled Weapons Department at Farnborough. After attending the Joint Services Staff College in 1950 he was seconded as senior principal scientific officer to the Scientific Adviser's Staff, Air Ministry. He returned to the Royal Aircraft Establishment as superintendent of the Guided Weapons Assessment Division in 1954 and has since been responsible for advanced work in the study of new weapon systems and air defence problems.

Mr. D. J. Lyons

MR. D. J. LYONS has been promoted deputy chief scientific officer to fill the post of senior superintendent, Ballistic Missile Division, in the Guided Weapons Department at the Royal Aircraft Establishment. He is a graduate of the University of London (Queen Mary College), where he obtained his degree in engineering in 1937. Following this, he joined the Aerodynamics Department at Farnborough, where he worked on wind-tunnel and full-scale stability and control problems. He had an interval of two years on flying duties in the R.A.F. before returning to Farnborough in 1941. Afterwards his work covered full-scale investigation of stability problems in new aircraft, particularly on spinning and autostabiliza-

tion, followed by a move to the Guided Weapons Department, where he took charge of the Division responsible for experimental projects, control physics and missile aerodynamics. He has for several years specialized in problems relating to ballistic missiles.

Mr. P. A. Hufton

Mr. P. A. Hufton has been appointed senior superintendent of the Supersonics Division of the Aerodynamics Department, Royal Aircraft Establishment. He was educated at the University of Manchester, graduating in 1933 in engineering. After obtaining his M.Sc. for postgraduate research on flow through labyrinth packing, he joined the Royal Aircraft Establishment in 1934. A period on wind-tunnels was followed by some years on aerodynamic research in flight. He built up and led a strong team dealing with the handling and performance aspects of take-off and landing and low-speed flight. He moved to the Aircraft and Armament Experimental Establishment at Boscombe Down in 1946, as one of the superintendents, and did much to establish revised methods of performance testing and handling assessment for the new types of aeroplane then emerging, his knowledge being used extensively both by the civil and military authorities. Returning to the Royal Aircraft Establishment in 1953, he took charge of the supersonic aerodynamics group at Farnborough, at a time when supersonic flight was rapidly mounting in importance, and this has now been followed by his new appointment as head of an expanded Supersonics Division of the Aerodynamics Department.

Automation and Technical Education

A debate on automation in the House of Lords on October 23 was opened by Lord Macdonald of Gwaenysgor, who emphasized the importance of research and of technical training, as also did Lord Crook; Lord Hall suggested that overhaul of training systems in Britain is urgently required. Lord Hailsham replied to the debate on behalf of the Government. He emphasized that clear-sighted planning, in direct consultation with the workers, is essential if automation is to avoid creating hardship; this is primarily the responsibility of management. He sees no reason why the consequences of the introduction of automatic machinery cannot be forecast far enough ahead for the individual employer to make his plans for recruitment and re-training his labour force, and to discuss well in advance with representatives of the workers how they will be affected. The Minister of Labour intends to discuss with representatives of employers and trade unions the period of notice in the contract of service and its relation to the length of service previously enjoyed, and has powers to assist transfers and training. In regard to education, Lord Hailsham strongly emphasized the impact which will be made upon the whole educational system of Britain, particularly on general education. It is still insufficiently appreciated that this is the real basis. Parents still do not realize the value of a technical secondary education, although there is increasing need for more craftsmen and technicians of all kinds and for new and modified types of training, and—most important of all—for more technologists and managers. Of non-recurrent grants of more than £25 million allocated by the University Grants Committee since the War, about one-third has gone to general university buildings of interest to all faculties, and 84 per cent of the remainder has gone to laboratories and other buildings for research and teaching in science and technology, including medicine. In regard to research, Lord Hailsham said that while the money provided under Conditional Aid Funds has come to an end, the continuation of the studies scheduled in the report on automation is receiving close attention, and it should not be assumed the work will come to an end.

Replying to a question in the House of Commons regarding progress in the extension of facilities for technical education since the publication of the White Paper, Sir David Eccles said on October 25 that the 1957–58 and 1958–59 building programmes have been approved and local education authorities know that they can start more than £40 millions worth of the five-year programme of capital investment. Eight colleges have been provisionally designated colleges of advanced technology and two designations confirmed. The National Council for Technological Awards has published its conditions for awarding the diploma in technology. The number of sandwich courses has risen from 103 to 168, and substantial increases of salary, recommended by the Burnham Committee for technical college teachers, have been approved. A committee, drawn from the National Advisory Councils on Education for Industry and Commerce, under the chairmanship of Dr. Willis Jackson, has been set up to report on the supply and training of teachers for technical colleges. The Minister has met representatives of local education authorities about regional co-ordination and inter-authority payments.

Awards for Postgraduate Study in Britain

New arrangements for awards for postgraduate study have been announced by the Ministry of Education and the Department of Scientific and Industrial Research, which have recently concluded in consultation with the Committee of Vice-Chancellors and Principals of Universities of the United Kingdom a full review of the present system. From 1957–58, the Department of Scientific and Industrial Research will offer a considerably increased number of competitive postgraduate awards in science and technology. These awards will be of two kinds: (1) *Research Studentships*, for postgraduate students seeking two or three years of supervised training in research, leading in most cases to a doctorate of philosophy; and (2) *Advanced Course Studentships*, for postgraduate students wishing to attend courses of advanced instruction in science and technology of not less than six months duration. The awards will be tenable at technical colleges as well as at universities. Their increased number has been so calculated that it will not normally be necessary for the Ministry of Education nor for local education authorities to make awards for postgraduate study in science or technology. Full details of these awards are being issued by the Department of Scientific and Industrial Research. Present arrangements for awards to students in medicine, dentistry, agriculture and veterinary science are not affected, nor are those for aiding graduates to train as teachers. Applications for the Department of Scientific and Industrial Research awards must be made through university or college authorities, and must reach the Department by March 1, 1957. The Ministry of Education is offering about 250 similar postgraduate awards, to be known as 'State studentships', for postgraduate study in arts subjects.

Chemical Industry in Britain

In his Messel Memorial Lecture to the Society of Chemical Industry on October 12, Sir Alexander Fleck, in reviewing some achievements and problems of the chemical industry, referred briefly to the life and work of Messel himself, particularly to his emphasis on the co-operation of science and industry, his insistence that specialization should be based on general education capable of stimulating the imagination and promoting independent thinking, and on the way he spent his working life at Silvertown living among the people who were employed by him. Sir Alexander suggested that if more employers and leaders had done this, the centres of chemical industry might have been made desirable residential neighbourhoods. He laid some stress in conclusion on this aspect of industry, urging that we cannot afford to make our surroundings either a geographical or a cultural desert, and that there must be sociological advance on many fronts, including a general advance in the educational level and a spirit of sincere service to the community. Sir Alexander also emphasized the need both on the management side and on the trade union side for a more flexible organization, capable of understanding current and impending changes; and while such an organization is being built up, the more intimate partnership of the works councils has an important part to play.

Looking at the achievements of the industry, Sir Alexander put the output of sulphuric acid at 2,095,000 tons in 1955 compared with 800,000–900,000 tons in 1881, and that of soda ash, soda crystals, caustic soda and sodium bicarbonate, which in 1881 was nearly 600,000 tons, probably exceeded 2 million tons in 1951. The output of dyestuffs had grown from 6,950 tons in 1907 to 42,900 tons in 1951. The average five-and-a-half-fold increase in the real value of production over a large section of the chemical industry in Britain between 1907 and 1951 can be compared with a three-fold increase for manufacturing industry as a whole; over the past five to ten years, the expansion for the whole industry was 9 per cent per annum, compared with 5 per cent for manufacturing industry as a whole.

Finance for the Department of Scientific and Industrial Research

Replying to a Parliamentary question in the House of Commons on October 23, Mr. J. R. Bevins, Parliamentary Secretary to the Minister of Works, as representing the Lord President of the Council, said that the five-year plan for the expansion of the activities of the Department of Scientific and Industrial Research provides for a financial review in the event of major variations in prices. This review has now taken place, and, subject to annual votes, additional resources will be made available up to March 1959 for grants to research associations and for other purposes. As the Department's receipts for paid services exceed estimates, it will be possible to maintain the number of awards to postgraduate students and other scientific grants during 1956–57.

University of Oxford

The issue of the *Oxford University Gazette* for October 16 gives some interesting statistics on the numbers in residence in the University and their various lines of study. There were 2,463 matriculations in 1954–55, an increase of nearly 3·7 per cent on the previous year, and for 1955–56 there were 6,207 men and 1,139 women in residence, making a total of 159 more than last year. The distribution of students under the six headings distinguished by the University Grants Committee is as follows, the first figures referring to men and the second to women: arts, 4,501 and 918; science, 1,139 and 163; medicine, 282 and 45; technology, 101 and 1; agriculture, 98 and 4; oversea services probationers, 52 and 1. The numbers of those taking honours schools in scientific or technical subjects in 1956 are as follows: mathematics, 68; physics, 74; physiology, 69; chemistry, 115 (part I) and 77 (part II); zoology, 23; botany, 12; geology, 5; engineering science, 29; geography, 57; agriculture, 9; forestry, 19; psychology, philosophy and physiology, 14; and biochemistry, 6 (part I) and 8 (part II). At Oxford, research students working for either the D.Phil. or B.Sc. in 1956 numbered 218 and 802, respectively. Though the University population is nearly 50 per cent greater than in 1938, the research side has obviously increased to a very much greater extent since then, for the comparable pre-war figures are: D.Phil., 67; and B.Sc., 78.

Statistics in the University of Sheffield

Through the generosity of the United Steel Companies, the University of Sheffield has been able to create an independent Department of Statistics, which began work as such at the beginning of this session. Provision for the teaching of statistics and for research in this field has hitherto been made within the Departments of Mathematics; but the growth of the subject and the very great increase in its use in wide fields of scientific and medical work—which in turn have meant many calls on the University staff in statistics—have rendered it desirable that a separate department should be established. This was already projected as a future development: the action of the United Steel Companies has made it possible to realize it at once. The head of the new Department, a post which carries the rank of senior lecturer in the University, is Dr. G. H. Jowett, hitherto lecturer in statistics in the University, whose post will be entitled "The United Steel Lectureship".

British Museum (Natural History): Recent Gifts

The British Museum (Natural History) has recently received a number of gifts, among which are the following. The Royal College of Surgeons has presented three sub-fossil human skulls from East Africa, thirty-five miscellaneous human skeletal fragments (mainly limb bones), eight models illustrating eruption of human teeth, and one primate brain-cast. Mr. Angus Booth (University College, Achimota, Gold Coast) has presented a large collection (114 specimens) of monkeys from the Ivory Coast, Gold Coast and Togoland, and four schoolboys have presented the considerable part of a skeleton of the rather rare narrow-nosed rhinoceros, *Dicerorhinus hemitoechus* Falconer, which they found in a peat deposit on the foreshore at Selsey, Sussex; further bones have been recovered by officers sent from the Museum, where the remains are being hardened and repaired. The cast of a skull of a child of the Old Stone Age, found with Mousterian flint implements in a cave of Teshik-Tash in Uzbekistan in 1938, has been received in exchange with the Museum of Anthropology, Moscow State University, and casts of the hand and foot bones of an early Neandertal man from Kiik-Koba, Crimea, have been received in exchange from the Institute of Anthropology, Leningrad, and the Museum

of Anthropology, Moscow State University. The skull of an early Inca or Pre-Inca individual showing seven trephinations which the owner survived, collected at Pachacamac, in the Department of Lima, Peru, by the late Dr. D. S. Matthews, has been presented by the British Andean Expedition to Mount Huagerancho (1956). An exchange has been arranged with the Meteorite Committee, Academy of Sciences of the U.S.S.R., Moscow, through Prof. E. L. Krinov, by which specimens of ten meteorites hitherto unrepresented in the Museum's collection at South Kensington have been acquired.

Supplies of Anterior Pituitary Hormones

Five of the individual Institutes of the National Institutes of Health, Bethesda, Maryland, are jointly providing the funds for the purchase or production of large uniform lots of anterior pituitary hormones, other than adrenocorticotropic hormone, purified to meet exacting specifications set by the Endocrinology Study Section both for potency and for low limits of contamination with other activities. The first lots of bovine growth hormone and of ovine prolactin have been approved by the Study Section and are ready for distribution. The growth hormone and prolactin are packed as sterile, lyophilized powders in vials of 50 mgm. and 25 mgm. respectively. Data on the estimated potency and degree of contamination, and instructions for dissolving the materials, are issued with each package. A pilot plant at Emory University is being set up under the direction of Drs. Stanley Ellis and Alfred E. Wilhelmi for the production of follicle-stimulating, luteinizing and thyrotrophic hormones. These materials will not be ready for some months. Grants of the hormones will be made to qualified investigators who apply to the Endocrinology Study Section, c/o National Institutes of Health, Bethesda 14, Maryland. Application may be made by letter giving a brief description of the proposed work, together with an estimate of the amount of hormones required. It is hoped that by this service both clinical and fundamental studies on the anterior pituitary hormones will be stimulated.

The Mond Magazine: a Journal on Products from Nickel-containing Ores

For a quarter of a century the *Nickel Bulletin*, published by the Mond Nickel Co., Ltd., has provided a monthly summary of the world's literature relating to nickel and nickel-containing materials. The Company has now instituted the publication of *The Mond Magazine*, which is intended to have a wider scope and different functions, though it will not, fortunately, supersede the *Bulletin* itself. The object of the new publication is to provide articles and notes on a wide variety of subjects related to all the products extracted from the Sudbury ores, which, in addition to the nickel, contain copper, cobalt, gold, silver, the platinum metals, selenium, tellurium, sulphur and iron ore. In the first issue (No. 1, July 1956; pp. 24) are articles on terramycin, the plant for which is constructed of a nickel–chromium corrosion-resisting steel; a short note on palladium in relation to its use in jewellery; stained-glass windows, in which cobalt, selenium and nickel, etc., are used as colouring matters; nickel–chromium steels in steering-rod assemblies; high-nickel cast iron; the use of nickel–chromium–molybdenum steel in the oxygen equipment for the 1955 Kangchenjunga expedition; the resistance of platinum to molten glass; and mechanical excavators. It is clear that this new publication, which can be obtained free of charge from the Publicity Department, Mond Nickel Co., Ltd., Thames House, Millbank, London, S.W.1, should interest a very wide variety of new readers.

Prehistoric Wooden Implements from Africa

Besides a note by Dr. A. S. Brink on some Thecodonts, Part 6, Vol. 1, "Researches of the National Museum, Bloemfontein", contains an interesting article by Dr. Desmond Clark on a wooden implement from the level of Peat I at Florisbad, Orange Free State. Florisbad is not a very satisfactory site. There are peats of various ages at these fossil springs, and when, as in 1912, local upheavals occur, their contents all tend to get mixed up. However, all the levels seem to be referable to some time in the Gamblian period. It is rare for wooden objects to have survived from prehistoric times. Only in exceptional circumstances can this occur. Dr. Clark, however, has himself unearthed an even more interesting example at a site (Kalambo) near Abercorn in Northern Rhodesia. Here the date is definitely late Acheulean. In both cases the working is of a simple order and not in itself of much importance; but the use of wood by very early man for tool-making purposes is now definitely established.

Bassi's "Del Mal del Segno"

To mark the centenary of the death of Agostino Bassi (see *Nature*, 177, 255; 1956), the University of Pavia has issued an attractive photographic-offset facsimile of the two parts of Bassi's monograph, "Del Mal del Segno" (1835, 1836). Loosely inserted is a brochure in which a note on the commemorative edition by Antonio Pensa is followed by a reprint of the appreciation of Bassi by G. B. Grassi from the collected edition of Bassi's works published in 1925, a list of the changes Bassi made in the second edition (1837) of "Del Mal del Segno", and a catalogue of Bassi's writings. A limited number of these facsimiles are for sale. Inquiries should be made to the Rector of the University of Pavia, Italy.

Royal Society Antarctic Expedition

The main party of the Royal Society Antarctic Expedition for the International Geophysical Year (July 1957–December 1958) under the leadership of Colonel Robin Smart will leave London on November 15 for Royal Society Base, Halley Bay, in the M.S. *Magga Dan*, which is being shared with the Trans-Antarctic Expedition. The party will relieve the advance party of ten men under the leadership of Surgeon Lieut.-Commander D. Dalgliesh who sailed from Southampton in November 1955 in the M.V. *Tottan*, and most of them will remain at Halley Bay until January 1959.

Oversea Service Division, Colonial Office

The following appointments have recently been made in the Oversea Service Division, Colonial Office: J. M. Arthurs (rural education officer, Federation of Nigeria), principal of the Farm Institute, Arapai, Uganda; D. R. N. Brown (assistant director of agriculture, Uganda), deputy director of agriculture, Uganda; V. E. M. Burke (assistant agricultural officer, Kenya), agricultural officer, Kenya; L. F. Derraugh (senior agricultural officer, Gold Coast), commissioner for food products, Department of Agriculture, Gold Coast; E. W. Findlay (agricultural officer, Eastern Region, Nigeria), senior

agricultural officer, Eastern Region, Nigeria; J. O. I. Longe (senior agricultural officer, Western Region, Nigeria), principal of School Agricultural Department, Western Region, Nigeria; R. F. A. L. Reed (principal of School Agricultural Department, Western Region, Nigeria), assistant director of agriculture, Western Region, Nigeria; E. Quist-Arcton (assistant conservator of forests, Gold Coast), senior assistant conservator of forests, Gold Coast; J. R. L. Bain (forest assistant Nyasaland), principal forest assistant, Nyasaland; K. H. Bryant (senior assistant conservator of forests, Federation of Malaya), conservator of forests, grade B, Federation of Malaya; C. Cairns (conservator of forests, grade B, Federation of Malaya), conservator of forests, grade A, Federation of Malaya; Foggie, A. (deputy chief conservator of forests, Gold Coast), chief conservator of forests, Gold Coast; J. M. Ramsay (senior assistant conservator of forests, Gold Coast), conservator of forests, Gold Coast; A. Ginsberg (veterinary officer, Kenya), senior veterinary officer, research officer (hygiene), Kenya; L. S. Pfob (veterinary officer, Uganda), senior veterinary officer, Uganda; P. T. Preston (veterinary officer, Kenya), provisional veterinary officer, Kenya; E. A. Wells (veterinary officer, Uganda), senior veterinary officer, Uganda.

Announcements

Prof. Charles Singer and Mrs. Singer have been awarded jointly the George Sarton Medal of the History of Science Society. The Medal was founded last year and the first award was to Sarton himself.

Robert Roesler de Villiers Awards of the Leukemia Society, Inc., have been made to Dr. L. O. Jacobson, professor of internal medicine in the University of Chicago, "in recognition of his pioneer experiments on the beneficial influence of local tissue shielding on general hematologic recovery after external irradiation—a fundamental discovery concerning a therapeutic weapon of continuing value in human leukemia"; and Dr. John F. Loutit, director of the Medical Research Council Radiobiological Research Unit at the Atomic Energy Research Establishment, Harwell, "in recognition of his elegant and conclusive demonstration that general hematologic recovery after total body irradiation is enhanced by bone marrow cell colonization, even from a different species—a discovery of potentially great significance in the therapy of human leukemia".

It is announced by the University of London that the title of reader in sociology has been conferred on Dr. R. T. McKenzie, and that of reader in industrial relations on Mr. B. C. Roberts, in respect of the posts held by them at the London School of Economics and Political Science.

The following have been elected officers of the Association of Clinical Biochemists: *President*, Prof. E. J. King; *Chairman*, Dr. R. Gaddie; *Treasurer*, Dr. I. MacIntyre; and *Secretary*, Dr. A. L. Tárnoky (Royal Berkshire Hospital, Reading).

Some time ago (*Nature*, **175**, 1066; 1955) reference was made to the "Coffee Pot", a club for young university graduates and professional people founded by Mrs. H. D. R. P. Lindsay. To meet the many applications, Mrs. Lindsay has now started a second club, the "Samovar", which has the use of the restaurant of the "Coffee Pot". Inquiries about the club should be made to the Membership Secretary, The Samovar Club, 108 Baker Street, London, W.1.

The British Society of Rheology is organizing a conference on "Rheology of Elastomers" to be held at the Rubber Producers Research Association at Welwyn Garden City during May 30–31. Further information can be obtained from the Honorary Secretary of the Society, 52 Tavistock Road, Edgware, Middlesex.

The Metallurgical Engineering Committee of the Institute of Metals is arranging an all-day informal discussion on "Degreasing", which will be held in the University of Birmingham on February 27. Members and non-members who would like to be present should notify the Secretary of the Institute of Metals, 17 Belgrave Square, London, S.W.1.

The annual exhibition meeting of the Botanical Society of the British Isles will be held in the Lecture Hall, British Museum (Natural History), on November 24, from 2.30 until 5.30 p.m. Further information can be obtained from Dr. J. G. Dony, 41 Somerset Avenue, Luton, Beds.

A small exhibition is being held in the University of Cambridge Engineering Department and will be open until November 17 to commemorate the publication of Sir Henry Bessemer's paper to the British Association entitled "On the Manufacture of Malleable Iron and Steel without Fuel". Exhibits include a showcase of original Bessemer steel specimens made between 1856 and 1859, lent by the Iron and Steel Institute; modern examples of steel made by the Bessemer acid process given by the Workington Iron and Steel Co.; a model of a Bessemer plant lent by the director of the Science Museum; a film strip projector automatically showing diagrams of the Bessemer converter in action; and photographs, notes and diagrams.

The Foundations' Fund for Research in Psychiatry has been given a grant of 3,682,000 dollars by the Ford Foundation for the support of the development of research personnel in mental health. It is stipulated that the money be expended or committed within five years, and it will be used concurrently with the present programme of fellowships and research grants in the field of psychiatry and related sciences. A brochure describing such awards can be obtained from the Foundations' Fund for Research in Psychiatry, 251 Edwards Street, New Haven 11, Connecticut.

Full-time courses on "Radioisotopes and Their Uses" are being arranged in the Department of Chemistry, Sir John Cass College, Jewry Street, Aldgate, London, E.C.3. These courses, which begin on January 14, are each of four weeks duration, and are a development of evening courses in radioactivity and radiochemistry established at the College in 1949. Additional facilities have been provided, and a new instrument room has been equipped for measurements and counting. Entry is restricted to graduates or others possessing an equivalent professional qualification. The fee for each course is £30.

The Wellcome Trustees announce that the office of their chairman (Sir Henry Dale) and their scientific secretary (Dr. F. H. K. Green) has been transferred from 24 Harley Street, London, W.1, to 52 Queen Anne Street, London, W.1 (Tel. Welbeck 5721/2).

Dr. W. M. Cumming, technical director to the British Dyewood Co., Ltd., and formerly professor of technical chemistry in the Royal College of Science and Technology, Glasgow, has retired in order to take up work as a technical consultant.

SCIENTISTS IN GOVERNMENT SERVICE IN BRITAIN

SPECIAL PROMOTIONS

FURTHER special posts have been created in the Civil Service, under provisions included in the White Paper on the Scientific Civil Service (Cmd. 6679; 1945), to provide for the promotion of individual research workers of exceptional merit. They include the following:

Deputy Chief Scientific Officers

DR. R. D'E. ATKINSON. Dr. Atkinson was appointed chief assistant at the Royal Observatory, Greenwich, in 1937, and in 1940 was loaned for degaussing work under the Admiralty. He is now at the Royal Greenwich Observatory, Herstmonceux. Dr. Atkinson is well known for his pioneer work on the mechanism of generation of stellar energy, but has in recent years turned his attention to the problems of positional and meridian astronomy, and has devoted considerable attention to the problem of flexure in transit instruments, this being a recognized source of error in accurate meridian work. He has designed a mirror transit which it is proposed to make for the Royal Greenwich Observatory.

MR. H. B. HOWARD. Mr. Howard joined the Scientific Civil Service in 1916. He has had long and varied experience in aircraft research, and since 1945 he has been assistant director of research on aircraft structures at Ministry of Supply Headquarters, in which capacity he has personally planned and co-ordinated aircraft structural research sponsored by the Ministry of Supply at the universities and in the aircraft industry. He is particularly distinguished as originator of the 'Howard diagram', for his early and far-sighted organization of research on flutter and vibration at the Royal Aircraft Establishment and for many substantial personal contributions to modern aircraft structural research.

DR. G. H. METSON. Dr. Metson joined the Post Office in 1933. Since 1946 he has led a team developing long-life, high-slope, pentode valves for submerged repeaters. His studies of oxide-cathode valves have led to a proper understanding of the causes of failure and to a production line employing novel techniques and rigorous testing and selection. In particular, passive platinum replaces active nickel for the cathode core; the growth of interface impedance and the excessive production and evaporation of metallic barium are thereby avoided and the means for activating and retaining activation on the passive core have been successfully found and explained. Subsidiary studies of other necessary materials and vacua have been made. His valves are in use in the Newfoundland to Nova Scotia section of the Trans-Atlantic Telephone Cable.

Senior Principal Scientific Officers

MR. I. M. DAVIDSON. Mr. Davidson works at the National Gas Turbine Establishment, where he has been primarily concerned with research in the aerodynamics of engines and has made notable contributions to the theory of supersonic flow and supersonic compressors, his recent work on the use of the jet flap to improve aircraft performance being particularly outstanding.

DR. K. H. DOETSCH. Dr. Doetsch is at the Royal Aircraft Establishment. Since 1953 he has been in charge of research and development of auto-pilots, autostabilization gear and powered controls.

DR. L. ESSEN. Since Dr. L. Essen joined the National Physical Laboratory in 1929 he has been concerned with precise microwave measurements, in particular with the measurement of frequency and time. Recently he has developed a frequency standard, based on a resonance of the cæsium atom, which offers the possibility of a more permanent, convenient and accurate fundamental time-standard than the astronomical standards hitherto used.

DR. F. A. ISHERWOOD. Since joining the Low Temperature Research Station, Cambridge, Dr. Isherwood has investigated the chemistry and biochemistry of the cell wall of plants and the soluble constituents of the cytoplasm. Recently, he has been studying the contribution which lignin and other phenolic substances make to the physical properties of the cell wall.

DR. M. S. LONGUET-HIGGINS. Dr. Longuet-Higgins joined the National Institute of Oceanography in 1954. Hitherto noted primarily for his important theoretical studies, he is at present particularly concerned with allied experimental investigations on the generation and changes in the characteristics of ocean waves and with the propagation of storm surges.

DR. L. W. MAPSON. At the Low Temperature Research Station, Cambridge, Dr. Mapson and Dr. Isherwood have made notable contributions to the knowledge of the role of ascorbic acid in plants and animals. Dr. Mapson's studies have been particularly concerned with the biological synthesis of vitamin C in plants and animals, the conditions of its stability and its role as a component of the respiratory enzyme system.

DR. H. SMITH. Dr. Smith has worked at the Microbiological Research Establishment since 1947. He has done outstanding research on the virulence-enhancing action of mucin and on the chemical basis of the virulence of the anthrax bacillus.

MR. J. K. ZBROZEK. Mr. Zbrozek has been working at the Royal Aircraft Establishment on the influence of atmospheric gusts on the flight dynamics of aircraft, using the 'power spectrum' method.

MR. H. ZIEBLAND. Since 1946 Mr. Ziebland has worked at the Explosives Research and Development Establishment, where he has applied engineering skill and theoretical and experimental ability in physics to problems of heat transfer, low-temperature research and thermal conductivity.

Similar promotions have been made by the United Kingdom Atomic Energy Authority as follows:

Deputy Chief Scientific Officer

DR. B. B. KINSEY. Dr. Kinsey became associated with atomic energy in 1942 when he joined the research team working at the Cavendish Laboratory, Cambridge, under the Directorate of Tube Alloys. When part of this project was transferred to Montreal, he joined the group engaged in the determina-

tion of the basic data required for nuclear reactors, and then, a year later, moved to the newly founded laboratory at Chalk River, Ontario. There Dr. Kinsey did notable work on the gamma-rays produced by neutron capture. In 1954 he spent a year at the Radiation Laboratory of the University of California as a guest of the United States Atomic Energy Commission, studying the interactions of high-energy protons with nuclei. Since 1955 Dr. Kinsey has held a special research appointment at the Atomic Energy Research Establishment at Harwell.

Senior Principal Scientific Officers

DR. G. C. BARKER. Dr. Barker is in charge of a small electrochemistry section in the group under Dr. E. Glueckauf. He has been responsible for the development of the square-wave polarograph which represents a major advance in polarography. He has studied the electrochemistry of ion-exchange resins and has recently applied the square-wave polarograph to the determination of ions in molten salts.

MR. W. B. HALL. Mr. W. B. Hall, of the Atomic Energy Authority Industrial Group, is in charge of experimental engineering in the Research and Development Laboratories at Windscale in Cumberland. He has worked on heat transfer and associated problems in reactors with both gaseous and liquid metal coolants.

MR. J. D. LAWSON. Mr. Lawson is distinguished for his work in electron physics. He has studied the behaviour of electron beams in accelerators and the radiation from targets bombarded by high-energy electrons, and has led a team in the development of new types of high-power klystron valves operating in the microwave region. He is at present head of a section of the Accelerator Group at Harwell, in charge of long-term research on particle dynamics in unusual configurations of electric and magnetic fields, with the help of electronic and mechanical analogues.

NEUROCHEMISTRY

INTERNATIONAL SYMPOSIUM IN AARHUS

THE word 'neurochemistry' is coming to mean something rather more than the bare chemistry of nervous tissues. At the second International Neurochemical Symposium recently held at Aarhus, Denmark, the discussion ranged freely from electron microscopy to problems of nervous transmission and drug action. While the metabolism of nervous tissues formed the central theme, the programme reflected a growing appreciation of the significance of biochemistry in relation to the morphology and function of the nervous system.

In the opening session, Prof. F. O. Schmitt, of the Massachusetts Institute of Technology, gave an admirably lucid account of the molecular structure and properties of the nerve cell membrane. He reported that isolated sections of nerve membrane obtained from squid giant axons show a relatively high metabolic activity *in vitro*, suggesting that the membrane may account for a large part of the metabolism of the whole cell. In a discussion of the nature and structure of the myelin sheath of medullated nerve fibres, it appeared that the new evidence obtained with the electron microscope agrees with that derived from X-ray studies in supporting the view that the myelin sheath is made up of concentric layers of a double membrane. According to the 'jelly-roll' hypothesis, the double membrane grows out from the point of contact of nerve axon and Schwann cell, and wraps itself around the axon; but it is difficult to apply this hypothesis to the myelin in the central nervous system. Mr. G. B. David (Cardiff) reviewed the structure of the synaptic terminations, of which some two thousand can be counted on the surface of the large ganglion cells of the brain. He presented evidence that some of the nerve endings terminate in fine filaments which enter the post-synaptic ganglion cells. Recent work on the mechanism of nervous conduction was described by Dr. R. D. Keynes (Cambridge), and the relation of phospholipids to the binding and transport of cations was discussed by Dr. J. Folch-Pi (Waverley). It appears that the phospholipids may be intimately concerned in the operation of the 'sodium pump'.

In a session devoted to the histochemistry and cytochemistry of nervous tissues, Prof. O. H. Lowry (St. Louis) described the spectacular work coming from his laboratory on the quantitative distribution of enzymes in individual ganglion cells, obtained by micromanipulation from different parts of the brain. Some enzymes are evenly distributed throughout the cytoplasm and others are located especially at the cell surface. Asked by Dr. M. G. Larrabee (Baltimore) if he had yet made measurements on individual mitochondria, Prof. Lowry replied: "No. But there is another Symposium in two years!". Cytological aspects of nucleic acid metabolism were reviewed by Prof. L. Einarson (Aarhus), who discussed in particular the changes associated with functional activity of the neurone. Dr. J. E. Edström (Gothenburg) reported a very outstanding piece of work on the purine – pyrimidine analysis of the ribonucleic acid in individual nerve cells of the hypoglossal nucleus, using a combination of chromatography on single cellulose fibres and ultra-violet microspectrophotometry.

Other sessions dealt with the general metabolism of the brain *in vivo* and of isolated ganglia, brain slices and peripheral nerve. The role of coenzymes in group activation was reviewed by Prof. F. Lipmann (Boston), and Prof. H. McIlwain (London) contributed a paper on the speed of chemical changes in the brain. Prof. H. Waelsch (New York) reviewed the nitrogen metabolism of the brain and described new results with radioactive lysine which confirm the earlier work with radioactive methionine in showing the high metabolic activity of the proteins. The rate of incorporation of labelled amino-acids is greatest in the microsomes, and Dr. D. Clouet (Cardiff) reported the isolation from the microsomes of a highly active nucleoprotein which accounts for a large part of the amino-acid turnover in the proteins of the brain. Lipid metabolism was discussed by Prof. R. J. Rossiter (Ontario) and Prof. E. Klenk (Cologne). Prof. F. Lynen (Munich) contributed a review of the role of acetyl–coenzyme A in the synthesis of fatty acids.

In the closing session, devoted mainly to the biochemistry and physiology of pharmacologically active compounds and drugs, Dr. W. Feldberg (London) gave an account of the role of acetylcholine in the central nervous system. Dr. M. Vogt (Edinburgh) described recent work on the distribution of adrenaline and noradrenaline in the brain, and concluded that the tranquillizing drug reserpine appears to act by

restricting the retention of basic metabolites in the tissue. Serotonin metabolism was reviewed by Dr. S. Udenfriend (Bethesda) and histamine by Dr. G. B. West (London).

The proceedings of the Symposium will be appearing shortly under the title "Metabolism of Nervous Tissue", edited by Dr. D. Richter and published by the Pergamon Press, London.

SOCIETY OF LEATHER TRADES' CHEMISTS

ANNUAL CONFERENCE

THE annual conference of the Society of Leather Trades' Chemists was held in the University of Leeds during September 21–22, the chair being occupied by the president, Dr. R. G. Mitton. The morning session of the first day was opened with a paper by Dr. G. H. Green on the mechanism of liming and bating. The main object of bating is to prevent adherence of leather fibres on drying, and evidence was put forward which leads to the following scheme:

$$\text{intact collagen} \xrightarrow{\text{lime}} \text{progelatin} \xrightarrow{\text{heat}} \text{gelatin} \xrightarrow{\text{trypsin}} \text{peptides of low molecular weight}$$

Progelatin consists of filamented collagen fibres produced on the newly formed collagen fibre-surface after liming or other swelling treatment, which, by its polar nature, acts as a glue when the fibres are dried. Removal of this progelatin restores the isoelectric point of the collagen, previously lowered to about *p*H 5·0 by alkali hydrolysis, and progelatin causes what is technically termed 'falling' and develops air-permeability and some silkiness of the grain surface of the pelt. Re-liming a skin after bating causes a serious loss of substance by progelatin formation, due to the bating enzymes assisting the action of the lime.

The tanning characteristics of aliphatic aldehyde–ketone resins were then discussed by J. R. B. Hastings and Dr. T. White. A resin tannage was described in which the hide is first impregnated with a condensate prepared by the alkali-catalysed reaction between an aliphatic aldehyde and ketone, which is afterwards resinified *in situ* by further alkali treatment. The leather can contain up to 20 per cent of resin with an increase in shrinkage temperature of 14 deg. C. The condensates can be converted into water-soluble products by treatment with sulphites or bisulphites and employed by conventional tanning methods. The role of the sulphonate group in the solubilized products was discussed and further compared with analogous sulphonated tanning materials. The aldehyde–ketone condensates were thought to have potential value if used with other tanning materials.

The last contribution to the morning session was a paper by Prof. D. Burton and Dr. R. Reed on some further electron-microscope researches, in which the structural changes in tanned collagen fibrils during shrinkage in hot water were described. First, the fibrils swelled either at certain regions along their length or at their ends. The bands across the fibrils became fainter in the swollen regions and, significantly, became much closer together. At the same time the swollen portions flattened and assumed a peculiar spiral form. This initial swelling was usually observed at a temperature below that of macro-shrinkage—that is, below that of a strip of leather as determined in the usual apparatus. Moreover, the fibrils in any particular sample of leather did not all swell and shrink at the same rate. On raising the temperature, the swollen fibrils broke across to form short stubby structures, which on prolonged heating were reduced to ill-defined masses of glue-like material. These changes appeared to take place with all the leathers so far examined, but were best illustrated in the case of chrome and oil-tanned leathers where the fibrils were not obscured by the presence of amorphous material such as vegetable tannin. On the basis of these results, suggestions were put forward for the structure of the native collagen fibril, its stabilization by tannage and its shrinkage by hot water.

The afternoon session was devoted to the delivery of the seventh Procter Memorial Lecture by Dr. G. W. Kenner, who selected for his subject the present and future scope of peptide synthesis. During recent years, great advances have been made in the analytical and structural chemistry of proteins and the question must be asked whether synthesis will keep pace. No deep and rapid incursion into this field should be expected, but progress in two directions is discernible. Oligopeptides containing some ten amino-acid residues arranged in a definite sequence can now be constructed from most, if not all, of the amino-acids which occur in proteins; the chief interest in such compounds has lain in their relation to hormones and antibiotics, but they may also prove useful as models in studies of protein reactions. Many polypeptides have been synthesized from single amino-acids, and the possibility of repeating many times a given short sequence is now apparent.

For building oligopeptides of defined structure, one still relies fundamentally on the approach made by M. Bergmann—namely, protection of the terminal amino-group of an amino-acid or peptide, while the terminal carboxyl group is condensed with the amino-group of another section of the peptide chain. However, the actual range of methods is now much greater than that which was available to Bergmann. In addition to Bergmann's carbobenzoxy-protecting group, one now has the tosyl, phthaloyl and trityl groups—to name only the most important—and in addition to the azide method of condensation, there are those methods relying on various mixed anhydrides, cyanomethyl esters, thiolesters, derivatives of trivalent phosphorus, and carbodi-imides. The power of these methods has been amply demonstrated in the syntheses of oxytocin and related compounds by du Vigneaud and his colleagues as well as by other groups of workers.

Polypeptides have been synthesized from the N-carboxyanhydrides of amino-acids; but this method is not applicable to the production of material containing more than one amino-acid and having a defined structure. For this purpose some of the methods used in the synthesis of oligopeptides can be adapted; but there are many problems in securing reasonable yields of material with a high molecular weight. Nevertheless, progress along these lines can be confidently expected.

The remainder of the afternoon of the first day was occupied by the annual general meeting of the Society.

The morning of the second day of the conference was opened with a paper by N. L. Holmes and H. G. Wollenberg on investigations into the rate of tannage of sole leather. In this work, which was devoted to

a study of the effect of temperature on the rate of tanning of sole leather, it was found generally that the total uptake of tannin increased with increase in temperature, as also did the rate of uptake, the temperature-levels used being 8°, 18°, 28° and 38° C. This was followed by the concluding paper of the meeting, by J. M. Harrison and T. Turner, on some experiments on the impregnation of sole leathers, in which were described some laboratory-scale experiments on the use of polymeric materials to improve abrasion resistance and water repellence of sole leather. The factors associated with emulsion impregnation and solvent impregnations were discussed. Many of the monomers, which on polymerization would give the type of elastomer required, are very volatile, and this has presented one of the difficulties. One method of *in situ* polymerization has been developed which gives a leather of improved properties.

LIBRARY PROBLEMS IN GREAT BRITAIN

IT is difficult to discern a common thread in the papers presented at this year's conference of the Library Association, held in Folkestone during September 18–21, though several of them stressed the importance of an adequate library system in relation to technological education and indeed to further education and the dissemination of information generally. In his paper on libraries in colleges of technology and further education, Mr. L. L. Ardern attacked the Government's failure to implement plans for an adequate national library service, at any rate for science and technology, and he was fully supported by Dr. G. Chandler and, at least by implication, by Mr. O. S. Tomlinson, who, reviewing post-war influences on librarianship, referred to the indifference of the teaching world, except in the universities and grammar schools, to the educational value of books.

Mr. Ardern began with a most interesting review of the early development of technical college libraries down to the official admission of their vital importance, which he welcomed, in the recent White Paper on Technical Education; but he showed convincingly how poor is the overall provision and how great is the need for some effective regional co-operation in each industrial area between the public libraries, the technical colleges and industrial libraries. Mr. Ardern remarked that we do not ask often enough how much duplication we can afford and suggested that this is a field where local co-operation would be particularly valuable, though the technical college library has to give priority to the subject fields of the departments it serves, and this limits the extent to which it can serve other fields.

Mr. Ardern fully recognized that the library is only a part of the technical college and that we cannot expect the part to be healthy, virile and progressive if the whole is not. He was clearly sceptical as to the Government's proposals for technical education providing us with colleges which are not over crowded, under-staffed and under-equipped. Dr. G. Chandler, discussing present trends and future developments in large municipal libraries, did not mention the technical colleges, but in his reference to special libraries, to technical libraries and to patent libraries he was likewise concerned with the Government's failure to implement the recommendations of the Advisory Council on Scientific Policy. The rapid dissemination of scientific and technical information is probably, he said, from the national point of view the most vital library problem, and large public libraries will not be able to meet the varied specialist demands of to-day unless the Government gives them much greater preferential treatment than at the moment. The Government does not realize, he said, that large public libraries are, in effect, national institutions and that they serve an even more advanced section of society than either the technical colleges or universities.

Dr. Chandler urged that libraries have as large a part to play in education as have schools and colleges, and that education is more than ever a pre-requisite of our survival in a fiercely competitive world. In this he and Mr. Ardern were fully supported by Mr. E. R. Lake in a paper on reading in the television age, as well as by the president of the Association, Mr. Edward Sydney, who concluded his presidential address by remarking that the public library service in any really democratic society is, and always will be, an essential instrument in enabling its citizens to live wisely, agreeably and well. Mr. Sydney devoted his address mainly to developments during the decade since the Second World War, stressing, like Mr. Ardern, in his more limited field, the need for greater co-operation, for high standards in provision of books, of service and of staff; Mr. Sydney also gave a brief glance at the international field, which was surveyed in greater detail by Dr. H. Coblans in a paper entitled "International Librarianship—Some Problems and Implications". To the scientist the chief interest of Dr. Coblans's paper lies in his reference to the opportunities which bibliography, documentary reproduction and translation offer for international action. Commenting that, in spite of some improvement in co-operation between national services in certain subjects, the abstracting services as a whole deteriorate every year, becoming more expensive, less complete in coverage and more numerous, Dr. Coblans said that international agreement to co-operate along well-defined lines offers the only hope of solution. *Chemical Abstracts*, he remarked, in 1956 costs six times what it cost in 1955. During the past few months Unesco has accepted some responsibility for defining the problems presented by the automatic printing of large numbers of references or index entries and the solution of items of knowledge on a given subject, and also for stimulating research and study for centres at various stages of library development.

Mr. D. J. Foskett, in a paper entitled "Science, Humanism and Libraries", maintained that science is much more than the accumulation of masses of data and that the failure to realize this is a major cause of misunderstanding and of breakdown in the communication of science. In the course of his work the scientist gains new knowledge and new ideas which are capable of inspiring him with emotions akin to those felt by the poet and the artist, and these have to be communicated in such a way that others also can appreciate their significance. Mr. Foskett thought that it is important to get into our libraries those works which deal with the specifically human side of science, such as the histories and biographies, and that one reason why scientists become so specialized in outlook is the mere mass of publication, some of a very low standard and much of it repetitious. He suggested that libraries should attempt to discourage

unnecessary publication and also that those possessing special knowledge should use their opportunities to produce works of wide interest, such as guides to the literature and bibliographies.

Mr. K. C. D. Vernon's admirable factual account of the libraries and work of some learned societies began, like Mr. Ardern's paper, with a historical review. Broadly speaking, he suggested, the strength of many of these libraries lies in their collection of periodicals, and he regretted that the holdings of many of these libraries are not recorded in publications such as the "World List of Scientific Periodicals". Some of these libraries have almost unknown riches on their bookshelves, and many have important collections of manuscripts. Many of them, however, are undeveloped and largely unknown except to small groups of people. Their resources could add much more to scholarship; but although some, particularly those serving expanding professions, have been forging ahead, recataloguing and rearranging their books, binding old books and introducing more up-to-date methods, much remains to be done before these libraries are fully mobilized to serve their societies.

THE MELLON INSTITUTE

REPORT FOR 1955–56

THE annual report of the president, Dr. E. R. Weidlein, to the Board of Trustees of the Mellon Institute, Pittsburgh, for the year ended February 29, 1956*, records that expenditure on pure and applied research was 5,009,213 dollars, of which 1,125,213 dollars was in support of original investigations in pure science in the Institute's five research departments and conducted under the auspices of thirteen fellowships. The report traces the idea of setting up a partnership between American industry and science, which the Institute represents, to Dr. R. K. Duncan who, after attending the Sixth International Congress of Applied Chemistry, held in Rome in 1906, arranged for the first industrial fellowship at the University of Kansas on January 1, 1907. During the past year 160 members of the Institute were engaged in pure science research projects and 412 members on the applied science researches conducted under fifty-eight fellowships. Of these seventy-one fellowships, 44 were multiple and 27 individual; four had been proceeding for forty years, four more for thirty-five years and six for twenty-five years.

Investigations in the Department of Research in Chemical Physics have included a detailed study of sodium, potassium and calcium salts to determine the magnitude of the anion effects in flame photometry, the redetermination of the infra-red spectrum of heavy benzene in both gas and liquid phases, and studies of the effect of temperature on the infra-red spectra of cyclohexane and dioxan; special equipment was assembled for measuring the intensity of X-ray scattering at very small angles. In the Department of Research in Physical Chemistry the study was completed of the effects of packing density and annular width on the separating efficiency of packed thermal diffusion columns, and work was considerably extended in chromatography. Three high-efficiency distilling units capable of handling charges up to 20 l. have been designed and installed, and a start made on the design of an automatic take-off system. Work on the determination and correlation of physico-chemical properties of hydrocarbons of high molecular weight continued, and the changes in pore-volume distribution of reactivated filtration clays are being followed in co-operation with the Multiple Petroleum Fellowship, and the absorption and desorption phenomena of porous glass in co-operation with the Glass Science Multiple Fellowship.

There is a continuing demand for workers in the Department of Instrumentation to construct instruments previously developed in it or by others, and also for training in the operation of instruments. In a basic study of the recording micro-balance and weighing techniques a procedure has been developed to adjust the instrument to be very insensitive to the tilt of the building and balance table. In the Department of Applied Mathematics a study has been made of the mathematical models used in predicting the concentration of atmospheric pollution; work has also been begun in the Department on programming and coding a routine for calculating structure factors used in crystal-structure analysis by the Department of Research in Chemical Physics, and assistance has been given the Multiple Glass Science Fellowship in determining light scattering in glass as a function of fluctuations in anisotropy and density and to the Multiple Petroleum Fellowship on statistical analysis and experimental design in the engine testing of petrol and oils.

Following preliminary studies, in co-operation with the Multiple Fellowship on Petroleum, with a Linganetype of potentiostat, the Department of Analytical Chemistry has provided a more widely adaptable instrument for coulometric analyses at controlled potentials and has expanded its microbiological and microscopical services during the year. A new microtome permits the preparation of cross-sections of biological and inanimate materials as thin as 0·05 μ, and a new stereoscopic microscope is an invaluable aid in selecting areas for photomicrography and for the examination of surfaces. A study of the effect of micro-organisms on petroleum and petroleum products was commenced, and procedures were formulated for cultivating and counting micro-organisms in aerosol dispersions. The expansion characteristics of starches and flours were studied in co-operation with the Food Varieties Multiple Fellowship, and the fundamental study of the chemo-synthetic autotrophic bacterium, which has been designated *Ferrobacillus ferroxidans*, isolated from bituminous coal-mines was continued.

Reviewing the work carried out under the Fellowships in Pure Science, the report stresses the work of the Industrial Hygiene Foundation, which has now completed twenty years of service to industry, including 380 companies in its membership, for which seven hundred special studies have been made as well as fifty basic research programmes in the Foundation's laboratories. Field investigations during the year included the determination of the magnitude of the in-plant contamination of the air with hexavalent chromium compounds, and the magnitude of fluoride exposures in specific areas of a chemical plant. A study was being made of the incidence of occupational dermatitis due to specific substances and the importance of these substances as causative agents in industrial dermatitis, and another

* Scientific Research Progress in Mellon Institute, 1955–1956. (Annual Report Series, No. 43.) Pp. vi+54. (Pittsburgh, Pa.: Mellon Institute, 1956.)

of the effects of abrasive dust on normal lungs and on the evolution of pulmonary tuberculosis. Work under the Multiple Fellowship in Chemical Hygiene is being devoted mainly to the study of the safety of chemical residues remaining in food as a result of new developments in its production, processing and packaging, and the low level has been demonstrated of sensitizing ability of a new epoxy resin catalyst now being introduced. Under a fellowship in the effect of atmospheric moisture on air-borne bacteria a better understanding has been yielded of the water exchange between bacteria and their atmospheric environment and of the way in which certain chemicals alter this relation when bacteria are dispersed from suspensions of these substances. The Fellowship in Mine-Acid Control is now applying the accumulated information of nine years to a large complete watershed in a coal-mining area. The Multiple Fellowship in Glass Science has developed improved procedures for measuring the nuclear-spin relaxation-times of the silicon-29 atoms in glass, continued its study of irradiated glasses and commenced experimental studies on the surface of glass. The Multiple Fellowship in the Properties of Synthetic Rubber, now sponsored by the United States National Science Foundation, has scrutinized the determination of macromolecular sizes by methods of intrinsic viscosity and molecular weight and also the application of this technique to studies of branching in polymers. The degree of orientation caused by stretching the elastomer has also been investigated, and the response of solid rubber compounds to sinusoidal stresses. A filler has been developed that possesses a static buoyancy similar to that of buoyant glass fibres, in which the inherent strength, bulkiness and resiliency of a synthetic staple fibre of extremely small diameter are combined with the water repellency of a silicone polymer, and further tests are being made of the efficiency of this product. By combining xerography with electroluminescent powders, workers under the Multiple Fellowship on Carpenter Components have produced panels containing self-luminous information displays, which appear to be specially attractive for instrument panels.

About 60 per cent of the report is concerned with the research programmes of the Fellowships in Applied Science, and among the points of more general interest which may be mentioned are the fundamental studies on the ageing of selenium rectifier plates made under the Multiple Fellowship in Power Rectifiers and the construction of a furnace to grow single crystals of silicon in a vacuum or in an inert atmosphere with independent pulling and rotation of the seed crystal. A study of the interaction of organic ammonium salts with bentonite has led to a stabler clay complex which is organophilic and hydrophobic and is used in gelling oils to greases and in controlling the thixotropy of oil-base paints. Considerable success has been achieved in determining the optimum water content for the proper extrusion of clay–water mixes by use of the 'Brabender plastograph', and an apparatus has been designed and constructed to measure the force-deformation characteristics of green clay bars under transverse sheer. Progress has been made in the development of cover-coat enamels with improved alkali resistance for use on sheet steel. Several interesting organic derivatives of zirconium have been prepared, and the production of a metal zirconium plate by electrolysis in non-aqueous media investigated. A comprehensive information-processing system, utilizing commercially available computers, communication systems and other devices, has been designed, and much basic research has been done on fundamental problems in the painting of steel structures, such as anchor-pattern profile, blast-cleaning inhibitors, and cleaning agents. An investigation of natural sediment in streams was commenced, and progress has been made with paper chromatography as a method for differentiating phenolic compounds and in a study of odour thresholds of pure phenolic compounds. Low-temperature crystallization techniques have been developed for the purification of organic compounds, and alloys of unusual characteristics have been developed by the electromelting of waste products from the recovery and utilization of anthracite.

Improved methods of synthesis have been devised for certain of the porphyrins and their metallic complexes, and the structure of the vanadium complexes determined. Volatility studies have been made on some of these metallic complexes, and studies initiated on the thermal stability of various sulphur concentrates from crude petroleums. A chemical shock tube has been designed and constructed for a fundamental study of combustion reactions, and a new micro-catalytic chromatographic technique developed for studying catalytic reactions, which promises to accelerate the accumulation of data on new catalysts. An extensive study was made of the chemisorption of nitrogen, carbon dioxide and carbon monoxide on nickel catalysts, prepared in the presence of alkali, and studies were continued on the composition and properties of fractions of high molecular weight from petroleum, while the use of calcium phosphates as a solid catalyst or catalyst carrier for various industrial reactions received detailed attention. Phase-contrast photomicrographs have been taken of a wide variety of plain and modified starches before and after heat treatment, and several modifications have been made in the method of synthesizing the bacterial starter from which salt-rising bread is manufactured.

A new dextrin has been developed for use as a high-performance size for filament acetate, and methyl glucoside has been used in the preparation of long oil-modified alkyl resins, oil derivatives and modified amino-formaldehyde resins. Compounds have been discovered with excellent detergency at low concentration in perchloroethylene, and the synthesis and evaluation of soluble linear polymers were continued; a comprehensive study of the autoxidation of polyalkylene oxide derivatives has revealed that carbon-to-carbon bonds along the whole length of the polyalkylene oxide chains, as well as terminal hydroxy-alkyl groups, are vulnerable to oxidative attack. Considerable effort has been given to the synthesis of materials for use as, or in, high-temperature lubricating and hydraulic fluids, and more than fifty systems were examined for the stabilization of vinyl films to heat and light. The field of polyethylene/paraffin wax blends for coating paper-container stock was explored further, and methods were sought for determining the wettability of a metallic surface by a coating and the ability of a coating to flow on a metal surface. New techniques were developed for the preparation of functionally active siloxanes, and a special glow-proofed 'Neoprene' foam, which meets flame and smouldering-resistance requirements, was being developed. Besides the preparation of 6-diazo-5-oxo-L-norleucine, which is highly effective in inhibiting the growth of malignant

tumours in mice and rats, studies of the mechanism by which the antibiotic, azaserine, inhibits the growth of malignant tumours showed that azaserine blocks at least one previously unknown enzyme from carrying out a key reaction involving L-glutamine and led to the identification of formylglycinamide ribotide as the reactant and formylglycinamidine ribotide as the product of the blocked reaction.

SPACE PERCEPTION IN CHICKS

ECKHARD H. HESS has carried out investigations to ascertain whether a chick's visual perception of space depends upon learning or upon the maturation of an innate ability (*Sci. Amer.*, July 1956).

Experiments were devised to prevent normal visual experience and which would not interfere with the normal physiological development of the eye. This was done by fitting the chicks' eyes with prismatic lenses which would displace the visual image to the right or to the left.

If the exact visual localization of objects in space is a totally learned ability, the chick's performance would be unaffected by the fact that it is wearing displacement prisms.

If, on the other hand, the chick is born with an innate ability to locate objects visually, the first pecks which such a chick directs toward objects seen through the displacement lenses would be about seven degrees to the right.

In experiments, twenty-eight Leghorn chicks were hatched in complete darkness and were immediately fitted with thin rubber hoods into which transparent plastic goggles had been inserted. The hoods were placed over their heads quickly in such a subdued light that the animals had essentially no normal light experience.

All the animals were returned to darkness for a period of about six hours so that they could become accustomed to the hoods. Then, when they were about one day old, all were tested for pecking accuracy. They were allowed to strike at small objects embedded in modelling clay. The targets were small brass nails, embedded so that they could not be dislodged by pecking.

There was a fundamental difference in the performance of control and experimental animals. In the control group the pecks were scattered about the target so that the target itself formed the centre of the distribution. For those chicks wearing lenses which displaced the visual field to the right, the pecks were similarly scattered; but they were centred about a point seven degrees to the right of the target. Similarly, the group the lenses of which displaced their visual images to the left showed a scattering of pecks to the left of the target.

Actual grain was now scattered and, when the chicks were between three and four days old, they were tested again. The results showed a great increase in accuracy on the part of the control chicks: now their pecks clustered quite closely about the target.

Among the animals wearing displacement prisms, improvement of a kind had also occurred. The pecks were clustered just as tightly as those of the controls, showing that increased accuracy had certainly been achieved.

It would appear that the chick's visual apparatus for locating objects in space is innate and not learned. This conclusion is based on the fact that the chick wearing displacement prisms clustered its pecks about the spot where the object was seen. It did not peck at random until it struck the target.

Moreover, the chick the visual field of which was displaced appeared unable to learn through experience to correct its aim. Its only improvement was to increase the consistency of the distance by which it missed the target. Apparently, the innate picture which the chick has of the location of objects in its visual world cannot be modified through learning if what is required is that the chick learns to perform a response which is antagonistic to its instinctive one.

Further experiments showed that adult chickens and newly hatched chicks used binocular cues for localizing objects in space. This innate organization for the perception of depth requires neither learning nor continued use for its presence in the adult animal.

HOME CARE AND NURSING

AN entire issue of *The Practitioner* is devoted to home care and nursing (**179**, No. 1057; July 1956). In an introductory article Dr. G. E. Godber notes two features of the National Health Service in Britain which have tended to be overlooked. One is that the Service depends primarily upon comprehensive home care, with hospitals and specialist services only for diagnosis and treatment of illness outside the scope of the family doctor and his supporting team. The other is that "the greatest innovations of the Service have been the domiciliary consultation with a consultant and the general provision of home helps". In other words, as Dr. Metcalfe Brown points out in his article on the domiciliary services available to the doctor, "The preventive services and the hospital service are there to help the family doctor, not to displace or replace him".

From the inception of the National Health Service the hospital service has absorbed a large proportion of the not inconsiderable sum which the nation spends upon the Service. Thus, during 1953–54, according to the Guillebaud Report, the hospitals absorbed more than 61 per cent of the £430 million spent on the Service that year, compared with only a little more than 12 per cent spent on the general medical service. Even if the cost of the pharmaceutical service is included in that of the general medical service, the proportion is still only a little more than 21 per cent.

There can be little doubt that if more attention were devoted to the development of the domiciliary services available to the general practitioner, the unnecessary load now carried by the hospitals would be radically reduced. Further, and equally important, the standard of general practice would be improved, to the greater benefit of the individual patient. The symposium provides an authoritative review of the services available to the general practitioner and of examples of how these services can be developed. The emphasis is upon the home care of children as these form such a vitally important part of the work of the family doctor; but all aspects of home care are integrated into the general picture. Three of the articles are written by medical officers of health. This is a sign of the increasing realization of the need for the closest possible co-operation between the medical officer of health, who is responsible for most of the domiciliary services, and the general practitioner, for whom these services are intended.

CASTE AND THE JAJMANI SYSTEM IN INDIA

IN works about caste it is rare to find an analysis of how the different groups interact with one another in the production and exchange of goods and services. William H. Wiser, in his book "The Hindu Jajmani System", described how goods and services are exchanged in a rural Indian village and analysed jajmani relations as a system. Knowledge of this jajmani system is essential for an understanding of the economic aspects of caste in rural India; its methods of working have been investigated and described by Prof. Oscar Lewis and Dr. V. Barnouw (*Sci. Mon.*, **83**, No. 2; August 1956).

Under the system each caste group within a village is expected to give certain standardized services to the families of other castes. A khati (carpenter), for example, repairs tools, while a nai (barber) cuts hair; but they do not necessarily perform these services for everyone. Each man works for a particular family or group of families with which he has hereditary ties. His father worked for the same families before him, and his son will continue to work for them, the occupation or service being determined by caste. The family or family-head served by an individual is known as his jajman, while the man who performs service is known as the jajman's kamin or kam karne-wala (literally, worker). These are the terms used in north-western India; where the system prevails in other parts of India other terms may be used.

It is a characteristic of the jajmani system to operate without much exchange of money. For it is not an open-market economy, and the ties between jajman and kamin are not like those of employer and employee in a capitalistic system. The jajman compensates his kamins for their work through periodic payments in cash or grain, made throughout the year on a daily, monthly or bi-yearly basis. Kamins may also receive benefits such as free food, clothing, and residence site, and the use of certain tools and raw materials. These concessions represent the strength of the system and are more important than the monetary payments. Despite the increased use of money in recent years, the peasants tend to prefer grain payments to cash, since grain prices have risen so enormously in the past decade.

There is evidence that the jajmani system exists in eastern Uttar Pradesh, parts of Malabar and Cochin, the Mysore District, Tanjore, Hyderabad, Gujarat and the Punjab.

A major function of the jajmani system is to assure a stable labour supply for the dominant agricultural caste in a particular region by limiting the mobility of the lower castes, especially those who assist in agricultural work. If a kamin leaves the village, he must get someone to take his place, usually a member of the same joint family. This does not usually involve sale, and the jajman is not likely to object, as long as the position is filled. Such transfers are rare, the kamins having valued rights and advantages which make them hesitate to move. Moreover, the community may put pressure on an individual to make him stay.

Jajmani rights, however, which link an individual to certain families, may be regarded as a form of property passing from father to son. Like land property, it is equally apportioned among brothers when they separate.

The widely held view that the caste system is crumbling rapidly in India is not borne out by examination. Although the jajmani system is tending to decline, this will not necessarily be followed by an automatic or speedy disintegration of the caste system. Instead, caste may continue to take on new functions and manifestations.

CAPILLARY FILTERS OF KNOWN AND ADJUSTABLE PORE-SIZE

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RODS of even thickness, when closely packed in parallel arrangement, produce a bundle of straight capillaries, with lumen corresponding approximately to one-sixth of the rod diameter. A possible use of such capillaries is in filtration, for example, by connecting an element of the kind shown in Fig. 1 to a syphon or some other suction system. Capillary filters of such structure are characterized by pores, which are (1) uniform, (2) of known size, (3) adjustable by more or less tightening the outer press. These three features have not been realized hitherto in any type of filter, in spite of considerable efforts in many instances[1]. Besides filtration, they open possibilities in other fractionations by size, for example, in sieving, diffusion, etc.

Among the materials which can be used in manufacturing capillary systems of the above kind, artificial textile fibres are of importance. Table 1 gives some characteristics of a few synthetic fibrillæ.

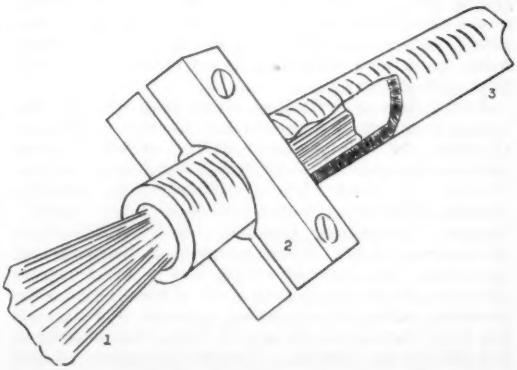

Fig. 1. (1) Rods and capillaries; (2) press; (3) plastic tubing

Table 1

Fibrilla	Composition	Cross-section (ref. 2)	Thickness (microns) (ref. 3)	Per cent swelling in water (ref. 3)
Acetate rayon	Cell. acetate	Crenulated	11 ± 30%	6–30
Casein	Protein	Circular	20 ± 13%	Very large
'Dacron'	Polyester	Circular	11 ± ?	0
Glass	Silicate	Circular	2·5 ± 20%	0
'Nylon'	Polyamide	Circular	11 ± 6%	2
'Orlon'	Acrylo-nitrile	'Dog-bone' shaped	18 ± ?	Very slight
Rayon	Cellulose	Crenulated	10 ± ?	'Viscose': 45–82 'Cu-NH_3': 99–134

The logical way of obtaining regularly packed rods from fibres is, of course, by reeling continuous filaments, for example, from commercially available bobbins. A procedure of this kind has been used by Hopkins and Kopany, who, however, were not interested in capillaries, but manufactured bundles of transparent fibres for the conveying of optical images[6]. For our purposes, the reeling is done on wheels the circumference of which is 2^n times the desired rod-length (n is any whole number), taking no particular care to deposit the fibres strictly parallel, because capillary forces arrange this automatically later, when the filter is wet.

Having deposited a counted number of turns, the pad obtained is cut open, taken off the wheel, and plied n times. Using a 'fish-wire', the 'tuft' is pulled into the tubing. If desired during this operation, the bundle can be given a precise length by neat cuts at both ends. A sharp knife is sufficient for cutting organic material. Glass can be sheared by scissors or cutting pliers (sawing by a 'Carborundum' disk—even water-lubricated—seems to produce sintering and plugging). As regards fibre length, I have observed that the rate of fluid transfer through the filters depends primarily on the zone of compression, being, for example, the same for filters cut flush with the faces of the clamp and others which extended in loose 'brushes' of irregular fibre length as far as 5 cm. beyond one or both sides of the restriction.

However, in filtration proper, these two types of capillary filters, the loose-end 'brush' and the clean-cut 'slice', may cause specific fractionation effects. The brush-filter and the slice (if at the end of the tube) are easily manufactured by the method described above. A filter-slice with free ends of tubing on both sides can be made by first cutting out a disk from a bundle of fibres packed within plastic tubing and then by pushing it into a larger tube, or by press-moulding or cementing it between two ends of tubing.

For a tube of 6·25 mm. inner diameter the following numbers of filaments can be used: 'Dacron' (DuPont 70-34-0-5,600-semi-dull), 20,000; glass (Owens–Corning *ECD*-900-1/0-'Fiberglass'), 8,000; 'Nylon' (DuPont 7-1-0-0-200-semi-dull), 40,000; 'Orlon' (DuPont 75-30-0-7281-semi-dull), 16,000; 'Rayon' (American Bemberg 50-36-44-*HH*-cupro ammonium), 4,000. These numbers of filaments and the press, the bore of which was $\frac{3}{8}$ in. (= outer diameter of the tube) with $\frac{1}{4}$ in. clearance for compression, allow of regulating aqueous flow (in ml. per hr.), through a syphon of 10-in. head, between 6·5 and 0·3 for 'Dacron'; 3 and 0·2 for glass; 7 and 0·05 for 'Nylon'; 4 and 0·5 for 'Orlon'; 3 and 0 for 'Rayon'.

Unfortunately, many fibrillæ (among them almost all natural and the thinnest artificial) are not available in continuous fibres. In this case, roughly parallel packing can be obtained by cutting staple fibres somewhat longer than twice the desired tuft length and then combing out the shorter fibrillæ. Weighing allows the estimation of the number of fibres per cross-section. For a tube of 6·25 mm. inner diameter, the weight in gm. per cm. length may be: for 'Rayons' and wool, 0·26; 'Nylon' and cotton, 0·35; for glass, 0·8. Otherwise, the procedure of manufacturing follows the pattern outlined above, the final packing and orientation by capillary forces being even more important here.

For various fluids specific interactions with the rod-materials can be expected. Water, for example, swells many fibres, as shown in Table 1. I have measured the decrease of water transfer (in ml. per 24 hr.) during consecutive days through capillary filters of cupro-ammonium 'Rayon' as follows: 11, 10, 9·5, 9, 8, 9, 8, 7·5, 5, 5, 5, 4, 4, 4, 3, 3, 3. Since the available space is limited by the outer press, expansion of the swelling fibres occurs into the capillary ducts, decreasing the lumen of pores. This can be used in constructing a capillary filter, with an outer metallic ring in place of a clamp, variable compressions and pore sizes being obtained by varying the number of fibres. For example, in the lumen of a 6·25-mm. tubing with an outer diameter of 9·375 mm., tightly fitted into a brass ferrule of 1 cm. in length, the following numbers of filaments (American Bemberg 50-36-44-*HH*-cupro ammonium) 3,800, 3,700, 3,600, 3,500, 3,400, 3,300, 3,200, 3,100, 3,000 gave, after two weeks of stabilization, flows of 0·0089, 0·024, 0·0328, 0·037, 0·0685, 0·089, 0·104, 0·1425, 0·226 ml. per hr., respectively, the head being 75 cm.

When using a water-resistant material like glass, several molecular layers of water are adsorbed by the surface of the rods[4], also producing clogging. Correspondingly, the flow of water through a capillary filter of glass decreases as follows under the same conditions as above: 11, 10, 9, 8, 7, 8, 7·5, 7. Obviously, the 'known' size of the capillaries cannot be calculated simply from the rod thickness in the 'dry' condition. It will vary and will have to be determined for each filtering medium. Presumably hydrodynamic methods will give strict answers, since the number of capillaries is known and their shape is very close to the ideal straight canals required by theory[5]. In an orientation test of this possibility, a glass filter composed of 816,000 fibrillæ, 6·275 microns thick, in tubing of 6·25 mm. inner diameter and an effective capillary length (zone of compression) of 10 mm., conveyed 22 ml. of water per 24·5 hr., the head being 121·5 cm. These flow data correspond to a capillary 'diameter' of 1·468 microns, whereas a geometrical computation yields 1·426 microns. (Assuming the arrangement of fibres as hexagonal-concentric, the ratio of holes to rods for the N'th row is $(2N-1):N$; the total number of capillaries tends to twice the number of rods with increasing counts of the latter.) On the other hand, the pore 'diameter' for the above cupro-ammonium filters with decreasing numbers of fibres has been calculated to be: 0·408, 0·530, 0·575, 0·600, 0·700, 0·750, 0·790, 0·869, 0·975 micron. These figures indicate 'diameters of pores'. However, under the microscope, cuts through closely packed swollen 'Rayon' fibres look more like regular hexagons of a tile-pavement, displaying no circular lumen. The pores are the rect-

angular gaps between hexagons, and the calculation of their width should probably be done by dividing the area corresponding to the above diameters, that is, 0·131, 0·221, 0·26, 0·283, 0·386, 0·44, 0·49, 0·58, 0·755 square microns by the length of a hexagon edge (approximately 8·5 microns). By this procedure the pore widths come out as: 0·015, 0·026, 0·030, 0·034, 0·045, 0·053, 0·060, 0·068, 0·090 microns. This should be closer to reality; but the ultimate determination of the size of the pores will be by filtration (diffusion, etc.) of particles of known diameters.

I may add that capillary coils as produced by wrapping sheets, and capillary boundaries between sheets in stacks (flat or curved) would give effects similar to capillaries between rods. As to specific action of surfaces, chemical and physical treatment of rods and sheets may result in interesting effects.

The foregoing is a by-product of sea-water demineralization research on the Berkeley Campus of the University of California. Though the study of capillary filters is only at its beginning, realizing their potentiality in many fields, Prof. E. D. Howe, director of the project, authorized this publication.

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A GENERAL CATION CARRIER IN THE YEAST CELL WALL

The General Carrier and its Amount per kgm. Yeast

IT has been shown[1,2] that when yeast ferments 5 per cent glucose in the presence of potassium ions, they are taken up readily and in exchange for hydrogen ions. If there is no buffering outside and the volume of the suspending fluid approaches a minimum then the *p*H in this way can approach 1·5[3]. The uptake of potassium is much greater if the external fluid is buffered to a *p*H of 4·0–7·0. This exchange has been theoretically explained by the acceptance of metabolic hydrogen atoms by a metal catalyst in the cell wall, hydrogen ions being split off and electrons retained. The reduced catalyst then transports potassium ions internally[4,5].

It has been found that other ions besides potassium can be absorbed—sodium, for example[6], at a *p*H of about 6·0. The sodium had an affinity for the catalyst of about 0·04 that of the potassium ion. Not only sodium but also many other inorganic cations can be taken up by the carrier. The order of the affinities are: hydrogen, potassium, rubidium, cæsium, sodium, magnesium, calcium[7].

Magnesium ions can be taken up actively by the carrier in surprising amounts at a *p*H of 6·0–7·0 provided there is no other competing cation outside[8]. Thus in 7-hr. fermentation at room temperature with yeast in twenty times its volume of medium containing 5 per cent glucose and 0·2 *M* magnesium acetate, about 100 millimoles mgm. are taken up per kgm. yeast. The magnesium is taken up by the same carrier as potassium, as shown by the fact that as little as 0·5 m.equiv. potassium/litre outside can reduce the magnesium uptake from 200 m.equiv./litre by 50 per cent and a few m.equiv. can reduce it almost to zero. That magnesium should be taken up in this way is a property of the cation carrier and proceeds by a different mechanism from that occurring with phosphate at a *p*H of 4·0. In this case potassium facilitates the magnesium uptake[9]. Very probably the magnesium transport by the general cation carrier has no normal physiological significance since there will always be present more than enough potassium to inhibit it.

The same general cation carrier seems to be operative when external cations are being exchanged for the actively excreted sodium ions from a sodium-rich yeast (non-fermenting), the order of the affinities being in general very similar.

The actual concentration of the general cation carrier was measured from the amount of potassium instantaneously adsorbed by it and its subsequent displacement with excess of rubidium. The radioactive isotope potassium-42 was used for measuring the minute amounts of potassium so released into the external fluid. In the procedure adopted, yeast was suspended in 0·6 its volume of 5 per cent glucose containing 0·02 *M* magnesium acetate (to satisfy the anionic charges on the cell surface) and cooled to 4–5° C., a temperature at which potassium uptake is considerably reduced but is still measurable. Then labelled potassium chloride was added to produce a concentration in the suspending fluid of about 1 m.equiv./litre, and after shaking vigorously for 30 sec. the potassium content of the supernatant was measured after centrifugation. To a similar suspension 30 sec. after addition of potassium, a very small volume of rubidium chloride solution was added to produce a Rb^+ concentration external to the cells of about 10 m.equiv./litre, and on shaking for a further half-minute the external potassium concentration was measured. The increase found was due to displacement of potassium from the carrier. The mean of thirteen such experiments gave 0·09 m.equiv. potassium displaced per kgm. yeast.

Since this method measured only the reduced form of the catalyst, the total concentration was measured by bubbling hydrogen through the suspension to remove all the oxygen present and so completely reduce the carrier. The potassium displacement, as a median for six experiments, was then found to be 0·12 m.equiv./kgm. It may be noted here that the difference between the amount of redox dye bound by the yeast in the completely reduced and completely oxidized conditions was approximately 0·15

m.equiv./kgm. yeast[10]. The iron content of yeast is about 0·60 m.equiv./kgm. wet yeast, mostly present in the cell wall[11], and the copper content about 0·06 m.equiv./kgm. Thus there is insufficient copper for binding the potassium but more than enough iron to act in the carrier enzyme.

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Active Transport of Magnesium

The general cation carrier in the yeast cell wall, referred to in the foregoing communication, can transport large amounts of magnesium into the cell during fermentation, when magnesium is the only cation present (apart from H^+) in the suspending fluid, and this has a *p*H of about 7·0. Thus when 1 gm. of centrifuged baker's yeast is suspended in 20–100 ml. of 5 per cent glucose containing 0·2 *M* magnesium acetate, about 100 millimoles of magnesium are taken up in 7 hr. The Mg^{++} exchange for hydrogen ions in a similar way to the active uptake of K^+ [1,2].

When sodium is taken up in a similar way it can be actively excreted by the yeast cells when these are washed and suspended in water. The excretion rate is much increased if the suspending fluid contains 0·1 *M* potassium chloride. In the latter case, sodium exchanges for K^+. On the other hand, magnesium accumulated in such a manner is not appreciably excreted on subsequent suspension in water or potassium chloride solution, even when glucose is added to the extent of 5 gm. per 100 ml.

Although very large amounts of magnesium can be taken up in this way by the yeast cell, the process seems to have no physiological significance, for it is almost fully inhibited by 2 m*M* K^+ in the presence of 200 m*M* Mg^{++}.

There is another mode of active magnesium uptake which has been studied by Rothstein[3], and also by Schmidt, Hecht and Tannhauser[4]. This occurs at or near a *p*H of 4·5 in association with phosphate and is increased by the presence of K^+. It would appear to be the normal mode of magnesium uptake during fermentation.

The active transport of magnesium by the general cation carrier requires the presence of oxygen, though the uptake of potassium by the same carrier can occur anaerobically. This may by explained by the inability of the redox system, when carrying the divalent Mg^{++}, to transfer its electrons to the acceptor system in anaerobic yeast. The active transport is inhibited by cyanide and azide as well as by anoxia. Of considerable interest is the fact that the active transport of magnesium, when this is present as the acetate, is not inhibited by 2,4-dinitrophenol (2 m*M*). Thus the evidence indicates that this active transport of magnesium after its attachment to the initial redox carrier requires the cytochrome–oxygen system for the further transfer of electrons and release of the transported Mg^{++} into the cell.

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A NEW METHOD FOR THE EXTRACTION OF DEOXYRIBONUCLEIC ACID FROM BACTERIA

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The extraction of deoxyribonucleic acid from bacteria, in a non-degraded state, raises some difficulties because of the presence around the bacterial body of resistant envelopes which prevent a rapid liberation in the medium of the molecules to be extracted. The method used by McCarty and Avery[1] consists of the lysis of the germs with sodium deoxycholate in the presence of sodium citrate as an inhibitor of deoxyribonuclease. This method yields a deoxyribonucleic acid highly polymerized and presenting a great biological specificity, but it is unfortunately limited to *Pneumococcus* and a very few other germs. The method of autolysis of bacteria, indicated by Boivin and Vendrely[2], allowed only the preparation of samples of deoxyribonucleic acid partially depolymerized. The methods, including mechanical processes of disruption of the germs (use of 'ball mills', shaking with glass beads, grinding with various abrasives)[3] are tedious and the yield is low and irregular.

We have devised a simple method for the extraction of bacterial deoxyribonucleic acid, using the lysozyme as a first step for the attack on the envelopes of the bacteria. This technique proved satisfactory for all

Table 1. Results of Extractions of Deoxyribonucleic Acid from Different Bacteria

Germs	Time of action of the lysozyme (in min.)	Amounts of DNA released at the first extraction (in per cent of the total DNA)	No. of extraction	Amounts of DNA extracted at the end of the experiment (in per cent of the total DNA)	Percentage of the DNA collected in a fibrous form
Bacillus megatherium	6–10	45	2	90	100
	30	45	2	90	100
Proteus vulgaris	10	31	3	85	100
	10	25	3	62	100
	15	29	3	62	100
	45	—	3	62	70
Escherichia coli	6	45	3	80	100
	15	45	3	80	100
	30	45	3	80	100
Staphylococcus	3	30	2	50	90
	10	45	2	76	30
	30	45	2	80	0

the germs we have tried so far—*Bacillus megatherium*, several strains of *Proteus*, several strains of *Escherichia coli*, one of which was completely refractory towards the extraction by grinding.

The bacteria are grown for 12 hr. (*B. megatherium*) or 24 hr. (*Proteus*, *E. coli*, *Staphyloccocus*). They are collected and washed twice with physiological saline solution, then they are resuspended in water saturated with chloroform[4] and left for 30 min. in a cold room. The killed bacteria are then centrifuged in the refrigerated centrifuge and resuspended in a 4/1,000 solution of sodium chloride (*p*H 7·0)[5] in the proportion of 10 gm. of fresh bacteria for 100 c.c. of solution. Crystallized lysozyme is added (0·5 mgm. lysozyme to 1 c.c. of the suspension) and the suspension is incubated at room temperature (20° C.) for a time varying with the bacterium (3–15 min.). The action of the lysozyme is then stopped by rapid cooling at 2° C. and the bacteria are centrifuged in a refrigerated centrifuge, washed twice in distilled water in order to remove the lysozyme and the degraded polysaccharides and the supernatant are discarded—the residue is frozen at −30° C. overnight. The extraction of the deoxyribonucleic acid is then achieved by resuspending the frozen residue in ten times its volume of distilled water with glass powder (the weight of glass powder added is twice the weight of the residue) and shaking the suspension for 30 min. in a cold room. (Other abrasives such as quartz powder, aluminium oxide, are not so efficient as glass powder.) The suspension is then centrifuged at low temperature, and the supernatant containing the deoxyribonucleic acid is collected. This operation must be repeated three or four times until nearly total extraction of the deoxyribonucleic acid is achieved. The solution of deoxyribonucleic acid collected each time is very viscous and little coloured; it is precipitated immediately by addition of three volumes of 95° alcohol. Repeated dissolutions and reprecipitations give a good purification of the deoxyribonucleic acid, though further purification can be attained by one of the methods described by Zamenhof *et al.*[6,7].

Table 1 shows the results of the different experiments performed.

The most important step in this method is obviously the treatment of the bacteria with lysozyme. This enzyme, destroying the polysaccharides of the bacterial envelopes, allows the dissolution of the deoxyribonucleic acid in the medium together with other substances of the bacterial body (ribonucleic acid, proteins). The chloroformed water, by killing the bacteria, makes the action of lysozyme easier.

Freezing makes the bacteria more fragile and increases their permeability, and shaking with glass powder facilitates the solution of the deoxyribonucleic acid by dissociation of the gel and adsorption of the deoxyribonucleic acid on the surface of the glass particles. The results summarized in Fig. 1 are quite significant: it can be seen, for example, that if the action of lysozyme is omitted, almost no deoxyribonucleic acid can be extracted. Concerning the time of action of lysozyme, there is a threshold which is not the same for the different bacteria: 6 min. for *E. coli*, 10 min. for *Proteus*, 6–10 min. for *Megatherium*, 3 min. for *Staphylococcus*. Beyond this threshold, the yield remains the same for longer times, so there is no need to use longer times of action for lysozyme.

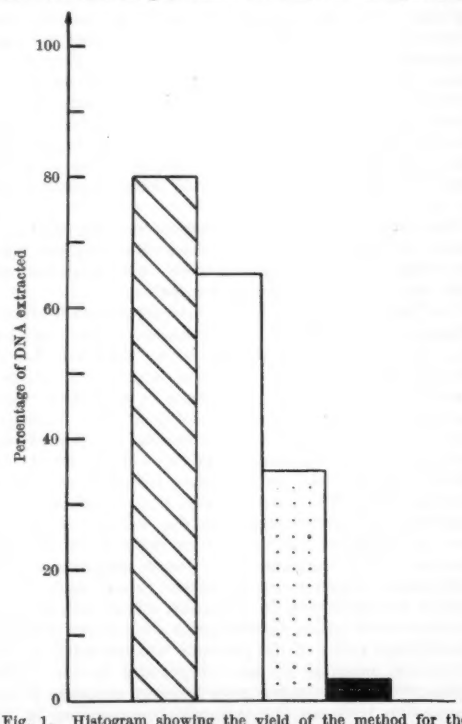

Fig. 1. Histogram showing the yield of the method for the extraction of deoxyribonucleic acid from bacteria (experiment performed on *Escherichia coli*) when various steps are omitted. Striped: optimal conditions. Plain: when germs are not frozen. Stippled: when chloroform is omitted. Black: when lysozyme is omitted

Moreover, the risk of autolysis is greater for long times and, in that case, the deoxyribonucleic acid extracted is no longer entirely polymerized. This fact is particularly striking in *Staphylococcus*, the deoxyribonucleic acid of which depolymerizes very rapidly in the course of extraction.

The degree of polymerization of the final product can be roughly estimated by considering the more or less fibrous state of the precipitate and the viscosity of the solution. When the method is used in optimal conditions, the yield of deoxyribonucleic acid is excellent. We have been able to extract 70–90 per cent of the acid contained in bacteria.

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A TEST OF A NEW TYPE OF STELLAR INTERFEROMETER ON SIRIUS

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We have recently described[1] a laboratory experiment which established that the time of arrival of photons in coherent beams of light is correlated, and we pointed out that this phenomenon might be utilized in an interferometer to measure the apparent angular diameter of bright visual stars.

The astronomical value of such an instrument, which might be called an 'intensity' interferometer, lies in its great potential resolving power, the maximum usable base-line being governed by the limitations of electronic rather than of optical technique. In particular, it should be possible to use it with base-lines of hundreds, if not thousands of feet, which are needed to resolve even the nearest of the *W*-, *O*- and *B*-type stars. It is for these stars that the measurements would be of particular interest since the theoretical estimates of their diameters are the most uncertain.

The first test of the new technique was made on Sirius (α Canis Majoris A), since this was the only star bright enough to give a workable signal-to-noise ratio with our preliminary equipment.

The basic equipment of the interferometer is shown schematically in Fig. 1. It consisted of two mirrors M_1, M_2, which focused light on to the cathodes of the photomultipliers P_1, P_2 and which were guided manually on to the star by means of an optical sight mounted on a remote-control column. The intensity fluctuations in the anode currents of the photomultipliers were amplified over the band 5–45 Mc./s., which excluded the scintillation frequencies, and a suitable delay was inserted into one or other of the amplifiers to compensate for the difference in the time of arrival of the light from the star at the two mirrors. The outputs from these amplifiers were multiplied together in a linear mixer and, after further amplification in a system where special precautions were taken to eliminate the effects of drift; the average value of the product was recorded on the revolution counter of an integrating motor. The readings of this counter gave a direct measure of the correlation between the intensity fluctuations in the light received at the two mirrors; however, the magnitude of the readings depended upon the gain of the equipment, and for this reason the r.m.s. value of the fluctuations at the input to the correlation motor was also recorded by a second motor. Since the readings of both revolution counters depend in the same manner upon the gain, it was possible to eliminate the effects of changes in amplification by expressing all results as the ratio of the integrated correlation to the r.m.s. fluctuations, or uncertainty in the final value. The same procedure was also followed in the laboratory experiment described in a previous communication[1].

There is no necessity in an 'intensity' interferometer to form a good optical image of the star. It is essential only that the mirrors should focus the light from the star on to a small area, so that the photocathodes may be stopped down by diaphragms to the point where the background light from the night sky is relatively insignificant. In the present case, the two mirrors were the reflectors of two standard searchlights, 156 cm. in diameter and 65 cm. in focal length, which focused the light into an area 8 mm. in diameter. However, for observations of Sirius, the circular diaphragms limiting the cathode areas of the photomultipliers (*R.C.A.* type 6342) were made as large as possible, namely, 2·5 cm. in diameter, thereby reducing the precision with which the mirrors had to be guided.

The first series of observations was made with the shortest possible base-line. The searchlights were placed north and south, 6·1 metres apart, and observations were made while Sirius was within 2 hr. of transit. Since the experiments were all carried out at Jodrell Bank, lat. 53° 14′ N., the elevation of the star varied between 15½° and 20°,

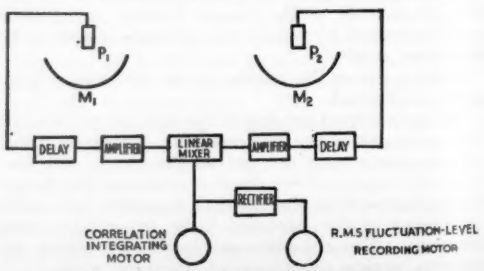

Fig. 1. Simplified diagram of the apparatus

Table 1. Comparison between Theoretical and Observed Correlation

1. Base-line in metres	2·5 (N.S.)	5·54 (E.W.)	7·27 (E.W.)	9·20 (E.W.)
2. Observing time (min.)	345	285	280	170
3. Observed ratio of integrated correlation to r.m.s. deviation: $C(d)$	+8·50	+3·59	+2·65	+0·83
4. Theoretical ratio of integrated correlation to r.m.s. deviation, assuming star has an angular diameter of 0·0063″: $C(d)$	+9·35	+4·11	+2·89	+1·67
5. Theoretical ratio of integrated correlation to r.m.s. deviation, assuming star is a point source: $C(o)$	+10·15	+5.63	+5·06	+4·40
6. Theoretical normalized correlation coefficient for star of diameter 0·0063″: $\Gamma^2(d)$	0·92	0·73	0·57	0·38
7. Observed normalized correlation coefficient with associated probable errors: $\Gamma^2(d)$	0·84 ± 0·07	0·64 ± 0·12	0·52 ± 0·13	0·19 ± 0·15

and the average length of the base-line projected normal to the star was 2·5 metres; at this short distance Sirius should not be appreciably resolved.

Throughout the observations the average d.c. current in each photomultiplier was recorded every 5 min., together with the readings of the revolution counters on both the integrating motors. The small contributions to the photomultiplier currents due to the night-sky background were measured at the beginning and end of each run. The gains of the photomultipliers were also measured and were found to remain practically constant over periods of several hours.

In order to ensure that any correlation observed was not due to internal drifts in the equipment, or to coupling between the photomultipliers or amplifier systems, dummy runs of several hours duration were made before and after every observation; for these runs the photomultiplier in each mirror was illuminated by a small lamp mounted inside a detachable cap over the photocathode. In no case was any significant correlation observed.

In this initial stage of the experiment, observations were attempted on every night in the first and last quarters of the Moon in the months of November and December 1955; the period around the full moon was avoided because the background light was then too high. During these months a total observation time of 5 hr. 45 min. was obtained, an approximately equal period being lost due to failure of the searchlight control equipment. The experimental value for the integrated correlation $C(d)$ at the end of the observations is given in the line 3 of Table 1. The value of $C(d)$ is the ratio of the change in the reading of the counter on the correlation motor to the associated r.m.s. uncertainty in this reading.

In the second stage of the experiment the spacing between the mirrors was increased and observations were carried out with east–west base-lines of 5·6, 7·3 and 9·2 metres. These measurements were made on all possible nights during the period January–March 1956, and a total observing time of 12¼ hr. was obtained. The observed values of the integrated correlation $C(d)$ are shown in line 3 of Table 1.

As a final check that there was no significant contribution to the observed correlation from any other source of light in the sky, such as the Čerenkov component from cosmic rays[2], a series of observations was made with the mirrors close together and exposed to the night sky alone. No significant correlation was observed over a period of several hours.

The results have been used to derive an experimental value for the apparent angular diameter of Sirius. The four measured values of $C(d)$ were compared with theoretical values for uniformly illuminated disks of different angular sizes, and the best fit to the observations was found by minimizing the sum of the squares of the residuals weighted by the observational error at each point. In making this comparison, both the angular diameter of the disk and the value of $C(o)$, the correlation at zero base-line, were assumed to be unknown, and account was taken of the different light flux and observing time for each point. Thus the final experimental value for the diameter depends only on the relative values of $C(d)$ at the different base-lines, and rests on the assumption that these relative values are independent of systematic errors in the equipment or in the method of computing $C(d)$ for the models. The best fit to the observations was given by a disk of angular diameter 0·0068″ with a probable error of ± 0·0005″.

The angular diameter of Sirius, which is a star of spectral type $A1$ and photovisual magnitude −1·43, has never been measured directly; but if we assume that the star radiates like a uniform disk and that the effective black body temperature[3,4] and bolometric correction are 10,300° K. and −0·60, respectively, it can be shown that the apparent angular diameter is 0·0063″, a result not likely to be in error by more than 10 per cent. (In this calculation the effective temperature, bolometric magnitude and apparent angular diameter of the Sun were taken as 5,785° K., −26·95, and 1,919″, respectively.) Thus it follows that the experimental value for the angular diameter given above does not differ significantly from the value predicted from astrophysical theory.

A detailed comparison of the absolute values of the observed correlation with those expected theoretically has also been made, and the results are given in Table 1 and in Fig. 2. In making this com-

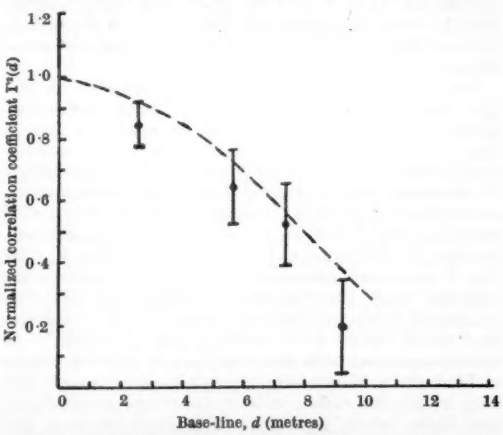

Fig. 2. Comparison between the values of the normalized correlation coefficient $\Gamma^2(d)$ observed from Sirius and the theoretical values for a star of angular diameter 0·0063″. The errors shown are the probable errors of the observations

parison, it is convenient to define a normalized correlation coefficient $\Gamma^2(d)$, which is independent of observing time, light flux and the characteristics of the equipment, where $\Gamma^2(d) = C(d)/C(o)$ and $C(d)$ is the correlation with a base-line of length d, and $C(o)$ is the correlation which would be observed with zero base-line under the same conditions of light flux and observing time. The theoretical values of $\Gamma^2(d)$ for a uniformly illuminated disk of diameter 0·0063″ are shown in line 6 of Table 1. For monochromatic radiation it is simple to evaluate $\Gamma^2(d)$, since it can be shown[5] that it is proportional to the square of the Fourier transform of the intensity distribution across the equivalent strip source; however, in the present case, where the light band-width is large, the values of $\Gamma^2(d)$ were calculated by numerical integration.

The theoretical values of $C(o)$, given in line 5, were calculated for the conditions of light flux and observing time appropriate to each base-line by means of equations (1) and (2) of our previous communication[1] (though in the present experiment the r.m.s. fluctuations were smaller by a factor $1/\sqrt{2}$ than the value given in the previous paper, which refers to an alternative electronic technique). The most important quantities in this calculation are the gains and output currents of the photomultipliers and the band-widths of the amplifiers; but it is also necessary to make a small correction for the combined spectral characteristics of the photocathodes, the atmospheric attenuation, the star and the mirrors. Finally, in line 4 of Table 1 the theoretical values of the correlation $C(d)$ are shown; they were calculated from the theoretical values of $C(o)$ and $\Gamma^2(d)$ by means of the relation given above.

The correlation observed at the shortest base-line (2·5 m.) can be used as a rough test of the effects of atmospheric scintillation on the equipment, since the corresponding theoretical value depends only on well-known quantities and is almost independent of the angular diameter of the star. Throughout the observations Sirius was seen to be scintillating violently, although the corresponding fluctuations in the d.c. anode currents of the photomultiplier tubes, which were smoothed with a time constant of about 0·1 sec., were only of the order of ± 10 per cent, as might be expected with mirrors large by normal telescope standards. Nevertheless, the observed correlation $C(d) = +8{\cdot}50$ does not differ significantly from the calculated value of + 9·35, and it follows that it cannot be greatly affected by scintillation.

The experimental values of $C(d)$ obtained at the four base-lines may be compared with the corresponding theoretical values $C(d)$ by means of lines 3 and 4 of Table 1. However, it is more convenient, since these values depend upon the different values of observing time and light flux at each base-line, to normalize the observed values of $C(d)$ by the corresponding values of $C(o)$, so as to give the normalized correlation coefficients $\Gamma^2(d)$ shown in line 7. In Fig. 2 these experimental values of $\Gamma^2(d)$ are shown together with their probable errors, and may be compared with the broken curve, which gives the theoretical values for a uniform disk of 0·0063″. It can be seen that both the relative and absolute values of $\Gamma^2(d)$ are in reasonable agreement with theory, and that within the rather wide limits of this preliminary test there is no significant difference between the correlation predicted and observed.

In assessing the potentialities of the technique described here, it is important to note that, although the measurements took five months to complete, the visibility was so poor that the total observing time was only 18 hr., while in this limited period additional absorption of 0·25–0·75 magnitudes due to haze or thin cloud was often present. If the observations had been made at a latitude where Sirius transits close to the zenith, the improved signal-to-noise ratio, due to decreased atmospheric absorption, would have made it possible to obtain the same data in a total observing time of about four hours.

Thus, despite their tentative nature, the results of this preliminary test show definitely that a practical stellar interferometer could be designed on the principles described above. Admittedly such an instrument would require the use of large mirrors. Judging from the results of this test experiment, where the peak quantum efficiency of the phototubes was about 16 per cent and the overall band-width of the amplifiers was about 38 Mc./s., one would need mirrors at least 3 metres in diameter to measure a star, near the zenith, with an apparent photographic magnitude + 1·5. Mirrors of at least 6 metres in diameter would be required to measure stars of mag. +3, and an increase in size would also be needed for stars at low elevation because of atmospheric absorption. However, the optical properties of such mirrors need be no better than those of searchlight reflectors, and their diameters could be decreased if the overall band-width of the photomultipliers and the electronic apparatus could be increased, or if photocathodes with higher quantum efficiencies become available. It must also be noted that the technique of using two mirrors, as described here, would probably be restricted to stars of spectral type earlier than G, since cooler stars of adequate apparent magnitude would be partially resolved by the individual mirrors.

The results of the present experiment also confirm the theoretical prediction[6] that an 'intensity' interferometer should be substantially unaffected by atmospheric scintillation. This expectation is also supported by experience with a radio 'intensity' interferometer[5,7,8] which proved to be virtually independent of ionospheric scintillation. It is also to be expected that the technique should be capable of giving an extremely high resolving power. Without further experience it is impossible to estimate the maximum practical length of the base-line; however, it is to be expected that the resolving power could be at least one hundred times greater than the highest value so far employed in astronomy, and that almost any star of sufficient apparent magnitude could be resolved.

We thank the Director of Jodrell Bank for making available the necessary facilities, the Superintendent of the Services Electronics Research Laboratory for the loan of much of the equipment, and Dr. J. G. Davies for his assistance with setting up the searchlights. One of us (R. Q. T.) wishes to thank the Admiralty for permission to submit this communication for publication.

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LETTERS TO THE EDITORS

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Time Courses of Motoneuronal Responses

THERE is now much experimental evidence supporting the postulate that excitatory and inhibitory synaptic actions are effective by the potential changes that are set up across the motoneurone membrane[1,2], the excitatory post-synaptic potential and the inhibitory post-synaptic potential being respectively in the depolarizing and hyperpolarizing directions. When generated by a virtually synchronous synaptic bombardment, these potential changes are approximately mirror images, the brief rising phases being followed by slower decays (Fig. *Aa*, *b*).

Further, it may be postulated that the subsynaptic currents (cf. inset, Fig. *B*) generating these potential changes have the same time courses as the synaptic transmitter substances that are responsible for them. Hitherto the time courses of action of the respective transmitters have been derived from analyses based upon the assumption that the approximate exponential decays of the excitatory and inhibitory post-synaptic potentials are determined by the passive decay of the charge that has been placed on the membrane capacity during the brief phase of transmitter action. It is known that the end-plate potential at the amphibian neuromuscular junction decays with the same time constant as that of the muscle membrane[3], and, as the time constants of decay of the excitatory and inhibitory post-synaptic potentials were considered to be approximately equal, it was argued that the electrical time constant of the motoneuronal membrane was the same as that of the decay of either type of post-synaptic potential, namely, approximately 4 msec.[4]. However, more accurate investigations, depending on the use of pure excitatory and inhibitory volleys, show that, while the time constant of decay of the excitatory post-synaptic potential is approximately 4·7 msec., that of the inhibitory post-synaptic potential is usually about 3·0 msec. (cf. Fig. *Aa*, *b*). Hence the time constant of the motoneuronal membrane cannot be derived by the above indirect procedure, and it becomes necessary to redetermine the electrical time constant of the membrane by more direct methods.

Motoneurones were impaled with double-barrelled micro-electrodes[4] filled with 0·6 *M* potassium sulphate solution, and the electrical properties of the membrane were determined by examining its response to rectangular current pulses passed through one barrel of the microelectrode. The consequent potential changes were recorded by means of the other barrel, using a cathode-follower input-stage the output of which was applied to one input of a differential

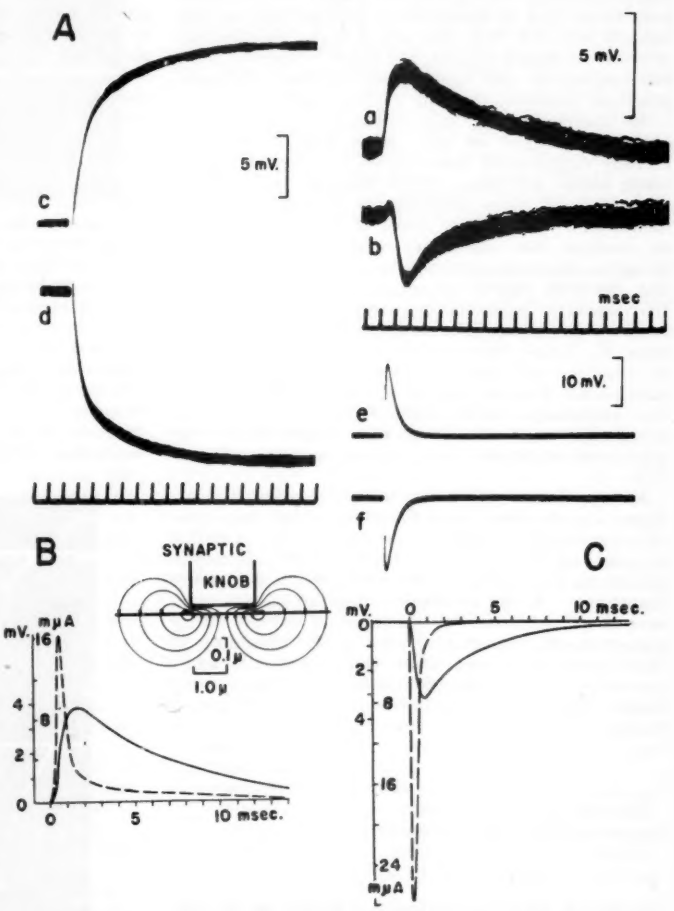

Fig. A. Potentials recorded from a biceps-semitendinosus motoneurone with a double microelectrode, both barrels being filled with 0·6 *M* potassium sulphate solution. Each record consists of forty superimposed traces. (*a*) Excitatory post-synaptic potential generated monosynaptically. (*b*) Inhibitory post-synaptic potential generated by impulses in the group I*a* afferent fibres from the quadriceps muscle. (*c*) and (*d*) Potentials generated immediately afterwards by rectangular current pulses of 12×10^{-9} amp. which are in the depolarizing and hyperpolarizing directions respectively. As shown in the extracellular records (*e* and *f*), the compensating network virtually eliminated all potential changes except those within 1·5 msec. after the onset of the pulse. The currents in *e* and *f* were 12×10^{-9} amp. in both the depolarizing and hyperpolarizing directions. Time constant values for this cell were higher than average, the membrane time constant derived from *c*, *d*, *e* and *f* being 3·1 msec. The excitatory post-synaptic potential decayed with a time constant of 5·5 msec. and the inhibitory post-synaptic potential with a time constant of 3·5 msec.

Fig. B. The continuous line is the mean of the monosynaptic excitatory post-synaptic potentials of Fig. *Aa*; ordinate in mV. The broken line shows the time course of the subsynaptic current required to generate this potential change derived by using the measured values of 3·1 msec. and $2{\cdot}4 \times 10^{-9}$ *F*. for the time constant and capacity of the membrane; ordinate scale in mμamp. The inset shows the direction of the subsynaptic current flow for an excitatory synaptic ending.

Fig. C. The continuous line is the mean of the 'direct' inhibitory post-synaptic potentials of the same cell (Fig. *A*,*b*). The time course of the subsynaptic current required to generate this potential change has been determined as in Fig. *B* and plotted by the broken line. It is of opposite sign, so would run in a direction opposite to that shown in the inset of Fig. *B*

amplifier. The difficulties caused by the resistive and capacitative couplings between the two barrels were largely overcome by applying the same rectangular pulses to an electrical network, which was adjusted to reproduce similar artefacts to those of the double microelectrode alone and which fed this signal to the second input of the differential amplifier. In this way it was possible to balance out almost all the artefact generated in the electrode. For any one cell, potentials due to the current pulses were recorded both intra- and extra-cellularly without altering the balance network (Fig. *A*,*c*, *e* and *d*, *f*). Subtraction of these potentials for any one value of current gives the magnitude and time course of the membrane potential produced by this current pulse.

As determined in this manner, the membrane potential attained its new value with an approximately exponential time course, the time constant being about 2·5 msec., which may be taken to be the electrical time constant of the motoneurone membrane. Using this value, it has been possible to analyse the excitatory and inhibitory post-synaptic potentials on the basis of Hill's local potential theory[5,6], and to determine the time courses of the respective subsynaptic currents (Figs. *B*, *C*) and hence of the transmitter actions. Both transmitters have an initial intense phase of action. Contrary to previous accounts[2], a residuum of excitatory transmitter persists during the decaying phase of the excitatory post-synaptic potential (Fig. *B*). A smaller residuum is usually observed for the inhibitory transmitter, but sometimes it is negligible (Fig. *C*).

Independent confirmation of the prolonged residuum of excitatory transmitter action has been provided by firing an antidromic impulse into a motoneurone at varying times during a monosynaptic excitatory post-synaptic potential, which is thereby destroyed[2]. If the antidromic impulse so acts even several milliseconds after the onset of the excitatory post-synaptic potential, a very small rebuilding of that potential occurs after the antidromic spike potential, which was previously overlooked[2], and which must be attributable to a small residuum of excitatory transmitter action.

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Cardiac Repolarization and Metabolic Blockade

Adrian[1] in 1921 showed that monophasic action potentials of the frog heart lasted up to 2 sec. at 14·5° C. and corresponded to the refractory period which normally protects the heart from erratic beating. He found that the action potential of a premature beat was shorter in duration than the preceding action potential. Measurements with intracellular electrodes have confirmed these findings; but no adequate explanation for the prolonged action potential of heart cells is available. Weidmann[2] has shown that the plateau of the action potential is a period of low conductance. He has suggested three types of change of K^+ or Na^+ permeability to account for this delay in repolarization. None of these hypotheses is quite satisfactory, so the problem has been approached by using metabolic blocking agents.

The plateau of depolarization in isolated frog atrium and ventricle is reversibly reduced in duration to about one-third of its normal length (Fig. 1*b*) by the action of 2 : 4-dinitrophenol at a concentration of 0·2 m.mole/l.[3]. Higher concentrations irreversibly shorten the action potential to one-sixth of its normal length. Sodium azide and neutral red, both of which interfere with oxidative phosphorylation, also reduce the duration of the plateau. Hypoxia acts in a similar fashion. The plateau appears to be linked, therefore, with supplies of high-energy phosphate. Further evidence for the dependence of recovery upon supplies of energy comes from the high-temperature coefficient of the plateau (Q_{10} 4–5)[4] and from the behaviour of the heart during extrasystoles and tachycardia. By driving excised amphibian hearts at different rates and recording intracellularly (Fig. 2), it was found that the rest pause coming before any action potential determines the duration of the next plateau of depolarization. In addition, the rate of depolarization becomes slower and the overshoot less, as the rest between beats is reduced. The relation between antecedent electrical diastole and the time of repolar-

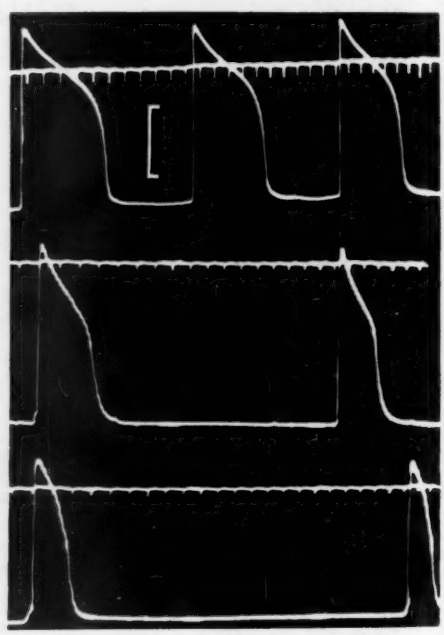

Fig. 1. Intracellular records of excised frog ventricle fibres at 22° C., beating spontaneously. (*a*) In normal Ringer solution, action potential duration 540 msec. and electrical diastole 360 msec.; (*b*) 10 min. in 0·2 m.mole/l. 2 : 4-Dinitrophenol + Ringer solution. Plateau shortened: action potential 320 msec., but rest pause 1,400 msec.; (*c*) 30 min. in 0·2 m.mole/l. 2 : 4-dinitrophenol. Action potential 210 msec., pause 1,960 msec., resting potential reduced by 6 per cent. 2 : 4-Dinitrophenol reduces the time of repolarization, and a long diastolic pause does not assist recovery of the plateau. (Time marks 100 msec., voltage 50 mV.)

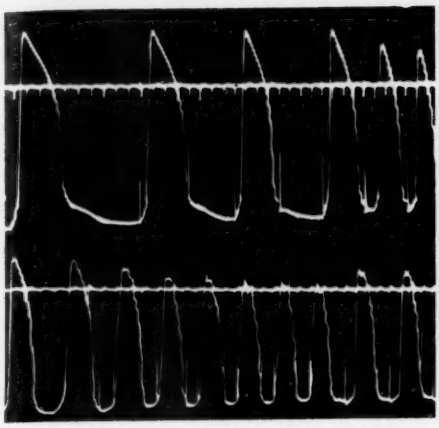

Fig. 2. Excised frog heart at 22° C. (*a*) Intracellular action potential of ventricle fibre. First potential shows fatigue after being driven, and action potential lasts only 350 msec. after 600 msec. rest; then driven at 2/sec. Shorter rest pause followed immediately by shorter action potential. (*b*) Drive 10/sec. with heart following each third and fourth stimulus. Reduced voltage and duration of action potential. (Time 100 msec.)

ization of the following action potential is linear in fresh hearts. The return of a long plateau after an exhausting period of fast activity is delayed, however, for several minutes (Fig. 2*a*), so the regression line then becomes a hysteresis loop. This behaviour may be interpreted as the restoration during electrical inactivity of specific energy sources to maintain the next plateau. When 2 : 4-dinitrophenol shortens the plateau of depolarization, however, a long rest is ineffective in prolonging the action potential (Fig. 1*c*).

Active transport of K^+ into nerve cells has been detected[5]. It is blocked by cyanide, 2 : 4-dinitrophenol and sodium azide. Acetylcholine shortens the plateau of heart fibres innervated by the vagus[6] and increases K^+ efflux[7]. None of these events, however, seems to provide a complete picture of the mechanism of the plateau. Active outward transport of such an anion as Cl^- offers a better, as yet untested, explanation. The plateau of the action potential is a period of low conductance, and it appears to be dependent on supplies of energy from oxidative phosphorylation which presumably are required for active ion transport. There is no conclusive evidence that the active ion transfer involves K^+ influx or Cl^- extrusion. Following the plateau, outward diffusion of K^+ would increase conductance and restore the membrane potential, though there may also be some active ion transport in this rather slow recovery phase.

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Essential Fatty Acid Activity of Docosapolyenoic Acids from Brain Glycero-Phosphatides

PREVIOUS work[1] has suggested that the presence of double bonds at the 6–7, 9–10 positions, counting from the terminal CH_3-group, is fundamental for the biological activity of essential fatty acids. This '6 : 9-(term.)'-hypothesis has directed attention to the highly unsaturated long-chain fatty acids from brain glycero-phosphatides[1]. According to Klenk[2], the C_{20} fatty acids of these phosphatides should contain two C 6,9-(term.)-acids, namely, C 11,14-eicosadienoic acid and arachidonic acid. The latter has long been recognized as an essential fatty acid, and, more recently, the former has appeared to be also active[1]. In the C_{22}-fraction of the brain glycero-phosphatides, six different fatty acids should occur, three possessing the 6,9-(term.)-configuration. Later, Klenk[3] succeeded in verifying the presence of these three 6,9-(term.)-acids by isolation and identification:

	Location of double bonds (terminal numbering)
C 7,10,13,16-tetraenoic acid	6, 9, 12, 15
C 4,7,10,13,16-pentaenoic acid	6, 9, 12, 15, 18
C 4,7,10,13,16,19-hexaenoic acid	3, 6, 9, 12, 15, 18

According to the theory, these acids should be active as essential fatty acids. In order to verify this supposition, fractions of highly unsaturated C_{22}-fatty acids from human brain glycero-phosphatides were tested for their bio-potency.

The isolation of these docosapolyenoic acids was carried out by one of us (H. de I.) under the guidance of Prof. E. Klenk at the Institute for Physiological Chemistry, University of Cologne, using a slight modification of Klenk's method[3] which involved the following steps: (1) dehydration of the brain and extraction with acetone; (2) extraction with ether of the phosphatides; (3) methanolysis of the phosphatides; (4) saponification of the methyl esters to fatty acids; (5) fractional crystallization by deep-freezing of the fatty acids in acetone solution; (6) esterification of the unsaturated fatty acids; (7) high-vacuum distillation of the ethyl esters, in order to separate the C_{18}-, C_{20}- and C_{22}-fractions.

In order to reduce losses on the walls and packing of the column, some paraffin oil (boiling point 160–190° C. at 10^{-4} mm. mercury) was added to the highly unsaturated fatty acid-ethyl esters prior to distillation. Eight fractions containing C_{22}-ethyl esters were collected (see Table 1).

It will be seen from Table 1 that the percentage unsaponifiable is fairly high. Very probably this is comprised entirely of the paraffin oil which was added prior to distillation.

Table 1. DATA OF THE INDIVIDUAL C_{22}-FRACTIONS

Fraction No.	Unsaponifiable (per cent)	Iodine value*	Conjugated dienes (per cent)	Conjugated trienes (per cent)
1	6	267		
2	6	293	1·5	—
3	9	293		
4	11	279	2·7	—
5	13	270		
6	16	268	6·9	0·1
7	16	246		
8	26	234	6·8	0·7

* The iodine values were determined by the method of Rosenmund and Kuhnheim and corrected for the percentage of the fractions which could not be saponified.

Table 2. Melting Points and Equivalent Weights of the Hydrogenated and Saponified Fractions

Hydrogenated fraction No.	Melting point (° C.)	Equivalent weight
1	77·0–79·0	354
2	78·0–80·0	341
3	78·0–80·0	340
4	79·0–80·5	339
5	80·0–80·5	339
6	78·5–79·5	339
7	75·5–76·0	346
8	75·0–75·5	349

Conjugated double bonds are present to a small degree, probably formed during distillation. Moreover, the corrected iodine values are somewhat lower *than could be expected from the values found* previously by Klenk[2].

To ascertain the purity of the fractions a small part of each fraction was hydrogenated, saponified and freed from the unsaponifiable portion, and after *recrystallization of the fatty acids from acetone*, their melting points and equivalent weights were determined.

As the melting point of behenic acid is theoretically 79·9–80·0° C. and its equivalent weight 340, it appears that fractions 2–6 consist of almost pure behenic acid.

The fractions were assayed in accordance with the method customarily used in this laboratory[1]. Some modifications were made. In order to avoid oxidation of the strongly unsaturated acids the animals (male Wistar rats) were given the total dose in one application instead of the usual daily dosing, the suitability of this depot method having been tested in preliminary experiments (unpublished work). For the same reason each animal was given 3 mgm. α-tocopherol (dissolved in 0·1 ml. of the ethyl esters of hardened coconut fatty acids). The ethyl esters of sunflower-seed oil fatty acids diluted with the ethyl esters of hardened coconut fatty acids were employed as a reference standard. The presence of paraffin oil in the distillate fractions might be an interfering factor; but one of the reference standards contained 10 per cent paraffin oil. It appeared, however, that paraffin oil in such small amounts did not influence the response.

As a unit for the bio-potency, the effect of 10 mgm. linoleic acid was taken[1]. The linoleic acid content of the reference standard was determined spectrophotometrically. The results of the bio-assay of the fractions are collected in Table 3.

The C_{20} fractions containing the highly active arachidonic acid and the weakly active[1] C 11,14-diene have a mean potency of 80 units/gm. The C_{22}-fractions, although somewhat less active than the *preceding ones, also show a (significant) potency* (mean: 38 units/gm.).

Table 3. Bio-potency of the Highly Unsaturated Fractions of Ethyl Esters of C_{20} and C_{22} Fatty Acids of Brain Glycero-Phosphatides

Fraction	Bio-potency (units/gm.)
A } C_{20}	100
B } C_{20}	62
C $C_{20} + C_{22}$	78
1	48
2	52
3	30
4 } C_{22}	39
5	36
6	23
7 } C_{22} + traces C_{24}	40
8 } C_{22} + traces C_{24}	50

In 1938 Hume[3] assayed a C_{22}-fraction obtained from cod-liver oil. The test animals showed only a slight positive reaction: their weights increased, but the *skin lesions did not heal. Possibly a structural* difference exists between the docosapolyenoic acids from the brain glycero-phosphatides of mammals and similar acids from fish oils[4].

Beauvallet[5] showed that the hexaene content of *the brains of rats decreases by about 50* per cent when the animals receive fat-free diets. The present results are in accord with the theory that a relationship exists between the essential fatty acids and the central nervous system. Moreover, they furnish *strong support for the 6,9-(term.)-hypothesis.*

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Factor I and γ-Aminobutyric Acid

Extracts of brain and spinal cord of mammals inhibit impulse generation in stretch receptor neurons of the crayfish[1]. The substance or substances responsible for this action has been referred to as Factor I[1]. In mammals this factor is present only in the central nervous system[1,2]. Partially purified preparations of the Factor have been found to imitate the action of inhibitory neurons in crustaceans[1,3] and to block synaptic transmission in autonomic ganglia[3] and monosynaptic spinal reflexes[4] of mammals. Factor I preparations were also found to activate the hypoglossal nucleus and often to stimulate polysynaptic spinal reflexes[4]. The inhibitory effects of Factor I in the spinal cord could be prevented by a subconvulsive dose of strychnine[4]. Partial purifications of Factor I have been obtained[1,2,4] by taking advantage of the observations that the factor is thermostable, dialysable, stable to acid and alkali, not precipitated by lead acetate or perchloric acid, soluble in methanol, moderately soluble in ethanol and insoluble in other organic solvents.

Factor I has now been found to be present in an occult, inactive condition in brain from which it can be released by heat, hypotonicity, or mild acid or alkali. Its production by brain is indicated by the fact that the activity found in brain suspensions increases with time. It has previously been reported that brain tissue can inactivate the factor[1]. The inhibitory effect of Factor I on the crayfish stretch receptor can be prevented by picrotoxin and metrazol, which are convulsants in the crayfish, but not by strychnine or camphor, which are not convulsants in this animal. These observations and those referred

to above suggest that Factor I may be a transmitter substance of inhibitory neurons and that interference *with its action may be the basis of the* convulsive effects of some drugs.

A convenient and rather accurate method of assay of Factor I has recently been developed using the crayfish stretch receptor as test object. This assay *has been used in work on the isolation* of substances which exhibit Factor I activity. Acetone-dried beef brain was extracted with 70 per cent ethanol. The evaporated extract was precipitated with acetone, washed with petrol ether and re-extracted with 95 per cent ethanol, and the ethanol was removed. Taking advantage of the fact that the active material underwent exchange with both strong acid and strong base ion-exchange resins, but not with either weak acid or weak base resins, a purified fraction was obtained which crystallized on evaporation from the water solution, and which represented a one-thousand-fold concentration of the activity over that of acetone-dried brain.

Fractional crystallization of this material has yielded three crystalline substances. Out of ethanol, on slow evaporation, clear, striated, rhomboid plates were obtained which showed the highest Factor I activity of any material yet encountered. A concentration of about 2 μgm. per ml. was sufficient to block the activity of the crayfish stretch receptor neuron. This material was identified with γ-aminobutyric acid by infra-red analysis, melting point, and paper chromatography. An authentic sample of γ-aminobutyric acid was found to have the same activity when assayed on the stretch receptor preparation. Two other types of crystals were obtained from acetone-water but have not been identified. One of these—needle clusters—was active and may be γ-aminobutyric acid; the other type—rod-shaped crystals—was inactive. The residue from the 95 per cent ethanol extraction retained an amount of activity approximately equal to that which dissolved in the ethanol. This activity, readily soluble in water, did not undergo exchange with either strong acid or strong base resins. The nature of this fraction is not yet known.

Among many α-amino-acids and other substances of biochemical interest which have been tested, only one was found to show Factor I activity. This was β-alanine, which was about one-twentieth as active as γ-aminobutyric acid.

The activity of Factor I is thus apparently the composite effect of several different substances. It is possible that the ethanol-insoluble fraction may be a complex or modification of γ-aminobutyric acid. The activity of β-alanine is low and may not be of physiological significance; its activity is presumably a result of its close structural similarity to γ-aminobutyric acid. Preliminary studies by Dr. Elizabeth Florey indicate that the content of Factor I activity in different regions of beef brain varies widely. The average activity of whole cerebral hemispheres from rats corresponds to that of about 200 mgm. of γ-aminobutyric acid per kilogram. Tentative estimates by Awapara *et al.*[5] of the γ-aminobutyric acid content of rat brain are somewhat higher than this. It thus seems likely that γ-aminobutyric acid may account for much of the Factor I activity found in brain.

The presence of γ-aminobutyric acid in brain was discovered in 1950 by Awapara, Landua, Fuerst and Seale[5], Roberts and Frankel[6], and Udenfriend[7], and it was shown that it is produced from glutamic acid by the action of a decarboxylase[5,6,8] with pyridoxal phosphate as coenzyme[9]. The metabolism of glutamic acid and glutamine and the numerous effects of these substances on metabolic activities, especially in brain, have been reviewed repeatedly. *It now appears that* a product of glutamic acid metabolism, γ-aminobutyric acid, may play an important part in the control of neurophysiological activity. Recent studies by J. E. Hawkins, jun., and L. H. Sarett, of the *Merck Sharpe and Dohme Research Laboratories, on* the anticonvulsant activity of substances known to be involved in brain metabolism, have also converged upon γ-aminobutyric acid. This compound is effective in preventing certain types of seizures in mice[10].

Pharmacological studies on the activity of γ-aminobutyric acid are in progress. It may be mentioned that injection of 0·2 mgm. of the substance into the hæmocœl of a 45-gm. crayfish causes the animal to become remarkably flaccid.

Details of this work will be published elsewhere.

We are indebted to Merck and Co., Inc., Rahway, N.J., for aid and co-operation in these studies. One of us (A. B.) is a member of the staff of the Merck Sharpe and Dohme Research Laboratories.

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Benzene Hexachloride Metabolism in *Anopheles gambiae*

WE have recently been able to examine the absorption and metabolism of benzene hexachloride by susceptible and γ-BHC-resistant strains of *Anopheles gambiae*. The resistant strain, which originated in an area of northern Nigeria where dieldrin is being used as a residual spray[1], was dispatched to England by members of the Nigerian Malaria Service and has been reared in the laboratories of the Ross Institute, London, by Dr. G. Davidson, who has kindly supplied the insects for our experiments. The resistant strain is some 800 times resistant to dieldrin and 26 times resistant to γ-BHC as determined by Davidson[2] using a modification of the method of Busvine and Nash[3]. The susceptible strain has also been reared in the laboratories of the Ross Institute in London and originated from Lagos, Nigeria.

In order to determine the absorption and metabolism of BHC isomers, deposits of carbon-14-labelled isomers were made from carbon tetrachloride solution in stoppered 100-ml. Ehrlenmeyer flasks and a weighed batch of mosquitoes (50–100 mixed sexes) added. A piece of untreated filter paper was included in the flask to provide a resting place for the insects. After 24 hr. at 25° C., the insects

Table 1. Absorption and Metabolism of α- and γ-BHC by *A. gambiae*
(Results expressed as μgm. BHC/gm. insect)

	γ-BHC			α-BHC		
	Susceptible	Resistant		Susceptible	Resistant	
	1	1	2	1	1	2
BHC absorbed	130	132	151	115	138	152
Water-soluble metabolites	14·6	8·0	9·9	14·8	4·8	8·0
Water-soluble metabolites as per cent of BHC absorbed	11	6·1	6·6	13	3·5	5·3

were removed and the radioactive material recovered and estimated as carbon tetrachloride - soluble and water - soluble fractions using techniques already described[3]. Comparative results for the susceptible and resistant strains are summarized in Table 1 for γ-BHC and α-BHC. Experiments with the α-isomer were included because it is known that γ-BHC-resistant flies are able to metabolize this isomer and the γ-isomer with equal facility, whereas experiments with α-BHC have the advantage of allowing a much longer survival of the γ-BHC – susceptible strain with correspondingly increased opportunity for the insects to exhibit their power of metabolizing the compound.

The results show that the resistant strain absorbs no less BHC than the susceptible, and converts a smaller proportion of the absorbed chemical to water-soluble products. (In another set of experiments not reported here, where the absorbed dose of γ-BHC was greater, the susceptible and resistant strains converted approximately equal amounts to water-soluble products.) Isotopic dilution tests with the pure BHC isomers showed that the radioactivity in the carbon tetrachloride extracts was almost all unchanged BHC ; carbon tetrachloride - soluble metabolites are therefore not produced in any significant amounts.

In all the experiments with γ-BHC, both strains were knocked down, the susceptible strain after some thirty minutes, the resistant strain after about three hours. A further experiment was therefore carried out in which exposure to the γ-BHC vapour was limited to 1 hr., after which the insects were transferred to a clean flask and stored at 25° C. for 24 hr. before analysis. The results are shown in Table 2.

Although the majority of the mosquitoes were alive at the end of 1 hr. exposure to insecticide and some of the resistant strain were still showing slight movements after 24 hr., the pattern of absorption and metabolism in the short-exposure experiment is very similar to that shown in the 24-hr. exposure experiments. Again the susceptible strain shows a greater percentage conversion of the absorbed γ-BHC to water-soluble products.

The results are published at this preliminary stage to direct attention to the fact that insecticide resistance can be exhibited by a strain of insects which possess no greater power of detoxication of the poison than the susceptible strain. The resistant *A. gambiae* can convert only 11 per cent or less of the absorbed poison to excretable products, the corresponding figures for a strain of resistant houseflies under similar conditions being more than 90 per cent[4]. It seems necessary to look to mechanisms other than detoxication for an explanation of the resistance of these *A. gambiae* to poisoning by γ-BHC.

Table 2. Absorption and Metabolism of γ-BHC by *A. gambiae*.
(Results expressed as μgm. BHC/gm. insect)

	Susceptible	Resistant	
	1	1	2
Outside (CCl_4-soluble)	2·8	2·0	3·6
Inside (CCl_4-soluble)	12·5	15·1	10·7
Water-soluble	2·8	2·0	1·2
Residue	0·0	0·0	0·0
Storage flask (CCl_4-soluble)	8·3	4·0	3·6
Total	26·4	23·1	19·1
Per cent metabolized	11	9	6

We thank Dr. G. Davidson for his collaboration and help in these experiments.

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A Simple Method for the Investigation of Peptides containing Cystine and/or Cysteine

The lability of sulphur-containing peptides makes their identification in tissues and fluids a peculiarly difficult problem. The simple procedure described here makes use of the fact that, while cysteine and cystine are held by a cation-exchange resin, cysteic acid is not. By transferring the cationic substances of a fluid to a cation exchange resin, washing it, and treating it with hydrogen peroxide, cysteine, cystine and peptides containing these residues are preferentially released into the supernatant fluid. Recovery of cysteine, cystine and homocystine was 77 per cent and of glutathione 25 per cent calculated from spectrophotometric estimation as their dinitrophenyl derivatives at 352 mμ. Methionine forms a sulphone which remains attached to the resin. Cysteic acid and oxidized glutathione could be separated by displacement chromatography from an anion exchange resin with *N*/10 hydrochloric acid. A simpler procedure utilized transfer of the oxidation products to a small amount of an anion exchange resin to remove them from the large excess of hydrogen peroxide, followed by displacement with hydrochloric acid and paper ionophoresis. The following examination of blood is typical.

The dialysate from 5 ml. of clotted human blood was mixed for one minute with the sulphonated polystyrene resin 'Amberlite' *IR* 120 (H) (2 gm.). Washing was performed by topping up the tube with distilled water, mixing, allowing the resin particles to settle, and sucking off the supernatant fluid. Sufficient 100 volumes hydrogen peroxide to cover the resin was added. After 6–18 hr. at 22° the supernatant fluid was washed through a filter paper into 'Amberlite' *IRA* 400 acetate (0·1 gm.), and mixed with it for one minute. After washing with water, 3 *N* hydrochloric acid (0·1 ml.) was added, and after one minute the supernatant fluid was taken to dryness at 22°. The residue was transferred to Whatman No. 31 paper and subjected to ionophoresis in *M*/10 diethylamine – acetic acid buffer *p*H 3·6 containing 5 per cent glycerol[1] in the apparatus of Flynn and de Mayo[2] at a potential difference of 200 volts for

3 hr. After drying the paper in a current of air, spraying with ninhydrin and heating, two spots, corresponding to cysteic acid and oxidized glutathione, appeared. The presence of glutathione in potato extracts was similarly demonstrated. Urine extracts contained substances which caused gross distortion of the ionogram. Considerable improvement was obtained by preliminary chromatography in butanol–acetic acid, the material running at the same rate as that giving a positive ninhydrin reaction on a marker strip being eluted and run ionophoretically. A strong cysteic spot and a weak spot moving at the same rate as oxidized glutathione was then detectable. Hydrolysates of blood and potato extract preparations contained only cysteic acid, glycine and glutamic acid; urine extracts contained, in addition, α-alanine and aspartic acid.

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Cleavage of N-Glycosidic Linkage in Peptide-ε-lysyl-N-glycosides by Ion Exchange Resin

It is well known that the sugar components of amino-acid-glycosides are not always detected in the acidic hydrolysates; this is in accordance with the general characteristics for the Amadori rearrangement[1]. However, there have been difficulties in elucidating the detailed structure of an amino-acid-glycoside which includes an oligosaccharide.

Recently, Finan and O'Colla have reported a method for the stepwise degradation of the glycosidic linkage in disaccharide osazones with the cation exchanger 'Zeo-Karb' 215 at room temperature[2]. This method has now been developed for the selective cleavage of the N-glycosidic linkage in ε-lysyl-N-glycoside without decomposition of the sugar components. The principle of this method is based on the observation that the anion resin 'Amberlite' *IRA*-410 hydrolysed the N-glycosidic linkage in peptide-ε-lysyl-N-glycosides, lactoside and lactuloside separated from the tryptic hydrolysates of milk products[3,4]; but the disaccharide remained unchanged under the same conditions.

A typical procedure is as follows: a column (10 cm. × 0·7 cm.) of 'Amberlite' *IRA*-410 (OH^- form) was washed with water and then 15 mgm. of the material dissolved in 1 ml. of water was placed on the column and left in contact with the resin for 10 min. The column was eluted with 1 per cent sodium hydroxide and passed through a column of 'Amberlite' *IR-4B* (H^+ form) in order to remove sodium. The neutralized elute was lyophilized to a syrup, which was shown by paper chromatography to contain disaccharide, lactose or lactulose and aglycone-peptide. The fact that the N-terminal-ε-amino group of lysine in the peptide was released by this treatment was also confirmed by means of the dinitrophenol method of Sanger and Tuppy[5].

On the other hand, somewhat similar experiments using 'Amberlite' *IR*-120 (H^+ form) as the absorbent and 1 per cent acetic acid as the eluting agent were not successful, since it was found that the lactoside remained and the lactuloside was split into several fractions. In addition, α-amino-acid-N-glycosides, namely, glycine-, alanine- and phenylalanine-fructoside prepared by the method of Abrams *et al.*[6], were also treated similarly with 'Amberlite' *IRA*-410. The results obtained, however, eliminated the possibility of degradation of N-glycosidic linkage in them.

On the basis of these results, it is accordingly suggested that the N-glycosidic linkage in peptide-ε-lysyl-N-glycosides are degraded selectively by 'Amberlite' *IRA*-410. This method was applied to the determination of the fine structure in the amino-acid-glycosides formed secondarily in the milk protein–lactose system[7]. Hence these results have perhaps a bearing on the nature and structure of amino-acid-N-glycosides formed in the protein–sugar complex and protein foods as the first intermediate in the amino-carbonyl (or Maillard) reaction of these systems. It is possible that further investigations, which are proceeding, will show that this result can be further generalized.

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Genetic and Hæmatological Significance of Hæmoglobin H

Late in 1954, I discovered two adult Filipino men unrelated to each other with a thalassæmia-like blood picture. Electrophoretic examination of hæmoglobin at *p*H 8·6 and 6·0 revealed a major component of normal hæmoglobin and a minor component with electrophoretic mobility faster than normal hæmoglobin A; further work led to identification of the new fraction as hæmoglobin H. Detailed studies on these patients will be published elsewhere.

Family studies on the inheritance of hæmoglobin H in a Chinese[1] and a large Greek[2] family as well as in a number of Thai[3] kindreds failed to demonstrate the abnormal pigment in the parents of the index cases with hæmoglobin H. Genetical investigations of these families revealed that one of the parents and several other members of the family had the thalassæmia trait without hæmoglobin H. The hæmatological findings of all cases with hæmoglobin H hitherto studied suggested the additional presence of thalassæmia. It may therefore be postulated that hæmoglobin H is only shown electrophoretically in the presence of thalassæmia. In this respect hæmoglobin H differs from most of the other human hæmoglobins such as A, C and S (and probably D, E, G and I) which are easily detectable in the trait or carrier state and the production of which presumably is under the control of multiple alleles. The finding of hæmoglobin H in thalassæmia has certain resemblances to the behaviour of hæmoglobin F, which is sometimes found in the thalassæmia trait and is not inherited quantitatively.

Since my two original patients were Filipinos, I recently examined the hæmolysates of seventy-three Filipino sailors (through the kind co-operation of Dr. E. H. Giblett, King County Central Blood Bank, Seattle, Washington) and three Filipino patients with non-hæmatological disease by paper electrophoresis at *p*H 8·6 (barbital buffer) and *p*H 5·8 (phosphate buffer), it having been found that hæmoglobin H could be best demonstrated at acid *p*H. No example of hæmoglobin H or any other electrophoretically demonstrable abnormal hæmoglobin was found. The absence of hæmoglobin H carriers in this limited population known to be a possible reservoir for hæmoglobin H provides further suggestive evidence that the trait for hæmoglobin H may not exist, or else has poor penetrance with the presently used methods of electrophoresis. The presence of pure thalassæmia trait without hæmoglobin H in siblings of patients with 'thalassæmia–hæmoglobin H disease' supports the latter hypothesis. Multiple allelism between thalassæmia and hæmoglobin H appears to be excluded since the combination of hæmoglobin H and thalassæmia has been reported[2] in the son of a patient with 'thalassæmia–hæmoglobin H disease'. Further surveys among Filipinos, Chinese, Greeks and related races need to be performed. In the present state of our knowledge, the demonstration of hæmoglobin H apparently signifies the simultaneous presence of thalassæmia. 'Thalassæmia–hæmoglobin H disease' therefore may be considered a variant of thalassæmia in which the thalassæmia gene in a yet unknown manner activates the expression of hæmoglobin H.

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Postnatal Formation of Hæmoglobin E

In order to find out whether hæmoglobin E is formed during fœtal life or some time after birth, the following investigation was carried out.

A survey for pathological hæmoglobin was carried out among women who were about to give birth to a child in the delivery room of the Department of Obstetrics of the Central General Hospital in Djakarta. The blood of babies of mothers carrying hæmoglobin E in their blood was examined at birth and at varying intervals after birth up to the age of three to five months. Among two hundred pregnant women, nine were found to be carriers of the hæmoglobin E trait, having hæmoglobin E in their blood in addition to the normal hæmoglobin A. Eight babies of mothers carrying hæmoglobin E in their blood were examined. At birth none of them showed hæmoglobin E in their blood on paper electrophoresis. Five of those babies could be followed up. Three who were examined at intervals up to the age of three to five months did not show hæmoglobin E in their blood when examined by paper electrophoresis. In the two other babies, hæmoglobin E was detected some time after birth. In one it was found when the baby was four months old while the fœtal hæmoglobin was 28·7 per cent of the total amount of hæmoglobin. At birth and at the age of 1½ months no hæmoglobin E could be detected in this baby by paper electrophoresis. At the age of 5½ months the amount of hæmoglobin E had increased while the amount of fœtal hæmoglobin had decreased to 10·3 per cent of the total amount of hæmoglobin.

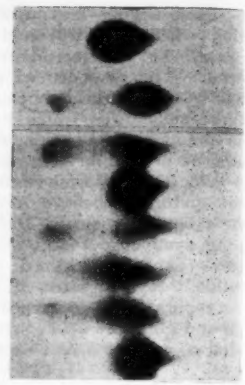

Fig. 1. Paper electrophoresis, *p*H 8·6, showing the postnatal formation of hæmoglobin E. (*A*) At birth no pathological hæmoglobin was found in the baby. (*B*) At the age of 2 months and 9 days a pathological hæmoglobin in a very low concentration with a mobility higher than that of hæmoglobin E was found, while at the age of 2 months and 3 weeks hæmoglobin E was clearly present in the blood

In the other baby no hæmoglobin E was found at birth, and the fœtal hæmoglobin was 80·1 per cent of the total hæmoglobin. At the age of 2 months and 9 days, however, a small amount of pathological hæmoglobin was found, which showed a mobility greater than that of hæmoglobin E. Since the father of the child was entirely normal, no pathological hæmoglobin other than hæmoglobin E was expected. Therefore the difference in mobility may be assumed to be caused by the very low concentration of hæmoglobin E found in the baby. However, the possibility of a transitional form of hæmoglobin E being formed at an early age could not be ruled out. This interesting point needs further investigation. At the age of 2 months and 3 weeks, the presence of hæmoglobin E in the baby was beyond doubt (see Fig. 1).

In these two babies, therefore, hæmoglobin E was formed some time after birth.

This investigation is the subject of part of a thesis written in Indonesian (May 1956). While the work was being carried out, a paper by Schneider and Haggard appeared[1] reporting the delayed formation of hæmoglobin S in several babies examined and the delayed formation of hæmoglobin C in one baby. Also, Thomas, Motulsky and Walters[2] have reported the postnatal formation of hæmoglobin C in one case examined.

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Multiple Hæmoglobins in the Blood of Animals

In the course of our investigations on the hæmoglobins in the blood of various animal species by the agar electrophoresis technique[1,2], it was found that the blood of buffalo contained two distinct hæmoglobins. Blood hæmolysates were prepared by the method of Drabkin[3] without using aluminium chloride. The hæmolysate was applied on the surface of the agar gel (0·5 per cent) containing 0·05 ionic strength barbital buffer of *p*H 8·6. Electrophoresis was carried out according to the procedure described before[4]. After electrophoresis (200 V., 6 m.amp., 6 hr.) the hæmoglobin bands could be observed visually. Under ultra-violet light using Wood's filter the bands could be seen more clearly. The hæmoglobin bands could be stained with amido black 10*B* after drying the agar plate and the concentrations of the components could be determined densitometrically. The region occupied by the hæmoglobins shows positive reaction with benzidine reagent. Rat blood hæmolysates showed the presence of two minor components of proteins in addition to the major component of hæmoglobin.

Typical hæmoglobin patterns of buffalo and rat, together with the normal human serum protein pattern obtained on the same agar plate for comparing the mobilities, are shown in Fig. 1. The mobility of the hæmoglobin of the rat blood haemolysate corresponds to that of β-globulin of human serum, while the other two minor components have approximately the same mobility as γ-globulin. Haurowitz *et al.*[5], in their study on the alkali denaturation of hæmoglobins, have suggested the presence of two or more components of hæmoglobins in rat blood as indicated by a break in the alkali-denaturation velocity curves. The identity or otherwise of these two minor components with hæmoglobin is being investigated further. The slow-moving component of hæmoglobin in buffalo blood has the mobility of β-globulin, and the fast-moving major component has a mobility higher than that of β-globulin. The blood of other animals investigated, namely, cow, sheep, goat, horse, dog, rabbit and guinea pig, contains only one hæmoglobin under the conditions of electrophoresis described, namely, at *p*H 8·6 and 0·05 ionic strength of barbital buffer. Harris and Warren[6] have, however, reported the occurrence of two hæmoglobins in the blood of some sheep examined by them.

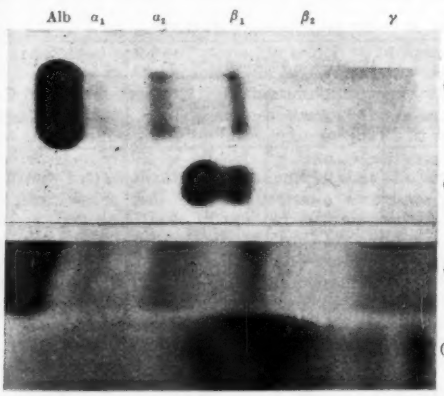

Fig. 1. Agar electrophoresis patterns of blood hæmolysates of buffalo and rat compared with the pattern of normal human serum proteins
a, normal human serum; *b*, buffalo blood hæmolysate; *c*, normal human serum; rat blood hæmolysate

Further characterization, isolation and amino-acid composition of the buffalo blood hæmoglobins are being studied. Investigations on the hæmoglobins of other animal species are in progress.

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Occurrence of *trans*-Unsaturated Fatty Acids in Horse Fæces

It has been shown recently[1,2] that whereas the depot fats of ruminants contain considerable amounts of *trans*-unsaturated acids (3·5–11·2 per cent) the depot fats of non-ruminants contain but little or none. Since the rumen bacteria exhibit a pronounced hydrogenating effect[3] and hydrogenation induces *trans*-isomerization, the occurrence of *trans*-acids in the fats of ruminants has been attributed by us to bacterial action[1,2]. This hypothesis has now found additional support from the determination of the *trans*-acids content of horse fæces from pasture-fed animals. The lipids isolated from fresh fæces (6·66 per cent on the moisture-free basis) contained approximately 14 per cent of these acids determined by the infra-red absorption technique[4] (Table 1), whereas no *trans*-acids could be detected in the depot fat of pasture-fed horses[1,2]. In view of the fermentative bacterial flora in the large intestines, and the reducing atmosphere in these organs, the above result is not unexpected, and points to a mechanism of *trans*-acids formation similar to that in the rumen, but occurring in the post-absorptive region of the gut. The iodine value and the diene and triene contents of the fatty acids from the fæces, shown in Table 1, indicate also extensive hydrogenation when compared with the corresponding data for the depot fat of the horse[5], and for pasture lipids[6].

On the other hand it is surprising that the carotene contents of the fæces (0·12 per cent of dry matter) was much greater than that of the pasture (0·05 per cent)[7], this being accompanied by a reversal in the ratio between carotene and xanthophyll, namely, 4 : 1 in the fæces against 1 : 2 in the pasture[6].

Table 1. Characteristics of Fatty Acids from Horse Fæces, Horse Depot Fat and Pasture

Source	Iodine value	% Conjugated diene	% Conjugated triene	% Unconjugated diene	% Unconjugated triene	% *trans*-acids
Horse fæces	37·8	1·2	nil	0·7	0·9	14·1
Horse depot fat	96·4	0·5	trace	3·3	16·1	Not detected
Rye-grass (*Lolium perenne*)	183·0	0·9	0·1	10·7	62·7	trace

The investigation of the *trans*-acids content of the fæces of various ruminants and non-ruminants is in progress.

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Influence of Nutrition upon Duration of Gestation in Sheep

Various effects of different planes of nutrition on pregnancy in the ewe have been studied; but there appears to be no record of an effect on duration of gestation. Four series[1] of observations were made, in which Merino ewes were maintained on high, medium and low planes of nutrition from the 108th, 129th, 136th or 143rd day of pregnancy to parturition. The distribution of the treatments among the four series is shown in Table 1. Prior to the experimental nutritional period, ewes had either been maintaining or gaining weight. During the experimental period, the ewes on the low plane in series 4 and 6 received chaffed wheaten hay only. All other ewes received a mixture of equal parts of oats and chaffed legume hay, with or without pasture. Ewes on the high plane of nutrition in each instance were allowed access to food *ad lib.* and gained about 0·2–0·4 kgm. in weight per head per day. In each series the ewes on the low plane of nutrition received about 0·2 kgm. (dry weight) of food per day each and lost about 0·2–0·4 kgm. in weight per day. Ewes on the medium plane received sufficient food to maintain constant body-weight.

All ewes in series 4, 5 and 7 bore single lambs. Some ewes in series 6 bore twins.

The mean duration of gestation in each group is set out in Table 1, together with the standard error of the mean, the number of ewes involved and the significance of differences. In each series, the mean duration of gestation of each group of low-plane ewes was less than that of each comparable group of high-plane ewes by amounts which ranged from 0·7 to 5·0 days. Most of these differences were statistically significant. In series 5, in which groups of ewes were subjected to a low plane of nutrition after the 108th or 129th day of pregnancy respectively, the mean duration of gestation was significantly the shorter by 2·3 days in the ewes in which the period of treatment was the shorter. The difference of 2·5 days was in the reverse direction in series 4, where ewes were subjected to a low plane of nutrition during the much shorter periods from the 136th and 143rd day of pregnancy to term.

A record was available of ewes which developed clinical signs of pregnancy toxæmia in series 7; the difference between means was still significant when ewes showing these symptoms were eliminated.

Although attention has not been directed by other workers to an effect of undernutrition upon duration of gestation, the data which Thomson and Thomson[2] present support the present findings. In their data, concerning ewes maintained on high and low planes of nutrition during the second half of pregnancy, the mean duration of gestation of the low-plane ewes which bore twins, 146·5 days, was significantly shorter ($P = 0·05$) than that of the corresponding high-plane ewes, 149·0 days; in ewes bearing single lambs, the respective means of 148·4 and 149·0 days differed in the same direction but the difference was not significant. These data clearly demonstrate that severe undernutrition may affect duration of gestation; but the lack of consistency between the results of series 4 and 6 indicates that the magnitude of the effect may vary in various circumstances.

The available data also suggest that in a group of comparable ewes the heavier the uterine contents are at the time treatment is commenced, the more is parturition advanced by undernutrition, provided treatment is not commenced within a few days of parturition. Thus it was more advanced among twins than among singles and among older fœtuses

Table 1. Mean Duration of Gestation of Ewes on Different Planes of Nutrition

Series	Group	Nutritional treatment: Plane	Nutritional treatment: Started (day of pregnancy)	No. of ewes	Duration of gestation (days): Mean	Duration of gestation (days): S.E.M.†	Duration of gestation (days): Difference between means (high–low)	Significance of differences between means‡†
7	*a*	High	108	33	148·8	0·36		
	b	Low	108	34	147·3	0·36	1·5	*a–b*, $P < 0·01$
5	*a*	Medium	108	19	150·5	0·57		
	b	High	108	20	151·0	0·56		
	c	Low	108	14	149·1	0·67	1·9	*b–c*, $P < 0·05$
	d	High	129	19	150·5	0·57		
	e	Low	129	18	146·9	0·59	3·6	*e–d*, $P < 0·001$ *c–e*, $P < 0·05$
6	*a*	High	136	4	148·5	0·52		
	b	Low	136	5	147·8	0·47	0·7	*a–b*, $P < 0·05$
	*c**	High	136	2	147·5	0·74		
	*d**	Low	136	3	144·7	0·60	2·8	*c–d*, $P < 0·05$
4	*a*	High	136	4	150·3	0·60		
	b	Low	136	5	145·3	0·53	5·0	*a–b*, $P < 0·001$
	c	Low	143	4	147·8	0·60	2·5	*a–c*, $P < 0·05$ *c–b*, $P < 0·01$

* Ewes bearing twins.
† In analysis of variance of each series, variance between groups was significantly greater than error variance ($P < 0·01$ or $0·001$).
‡ Values of P were determined by '*t*' test using error variance from analysis of variance.

than among younger ones except where underfeeding was commenced close to term. This suggestion supports the hypothesis which was advanced as early as 1891 by Spiegelberg[2] that insufficiency of fœtal nutrition is a factor concerned in the initiation of parturition. Certainly the fœtus or fœtal placenta must be concerned in this process, as a sire influence on length of gestation in sheep has been demonstrated by Terrill and Hazel[4]. This suggestion and Spiegelberg's hypothesis provide a basis for an obvious explanation of the findings, reviewed by these workers, that gestation in ewes bearing twins is usually shorter than in ewes bearing singles.

The present results add another item to the list of those which must be explained by any hypothesis about the factor or factors which actually precipitate parturition.

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Visual Pigments of Deep-Sea Fish

Experiments have been made on board R.V. *Sarsia* with the fresh retinæ of four species of deep-sea fish caught in the Bay of Biscay. These species, *Stomias boa* (Risso), *Flagellostomias* sp., *Argyropelecus olfersii* (Cuvier) and *Myctophum punctatum* Rafinesque, are often caught around 500 m.[1], a depth close to that at which the human eye ceases to see the light of day[2].

Simple visual inspection showed that the unbleached retinæ were golden coloured. Fig. 1 demonstrates that the changes in spectral absorption on bleaching such retinæ were those of retinal photosensitive pigments differing from visual purple in having their maxima displaced about 20 mμ toward the blue end of the spectrum. The retina of the conger eel has recently been shown to contain a pigment with an absorption curve very similar to those described here[3,4] (Fig. 1). The conger begins life in the deep ocean and returns there when mature.

The golden-coloured pigments which were found in high density in all these retinæ are admirably suited to make the best use of that fraction of daylight which penetrates deep into oceanic waters. These waters are most transparent to blue light around 475 mμ[5], and at depth this is effectively the only light.

Wald[6] has made the generalization that the retinæ of fresh-water fish contain purple pigments (porphyropsins) and those of coastal marine fish contain rose pigments (rhodopsins). We may now add another group, those of deep-sea fish the retinæ of which have principally golden-coloured pigments for which we suggest the name chrysopsins or visual golds.

We are grateful to Mr. N. B. Marshall of the British Museum (Natural History) for identifying the deep-sea fish and to Captain C. A. Hoodless and the crew of the Marine Biological Association's research vessel *Sarsia* for their enthusiastic co-operation.

The kindness of the Director of the National Institute of Oceanography has enabled the results described here to be confirmed and extended by experiments made aboard R.R.S. *Discovery II*. Fifteen species of deep-sea fish were found to have golden-coloured retinal photosensitive pigments and only one oceanic fish, a surface form, *Saurus scombresox*, to have visual purple.

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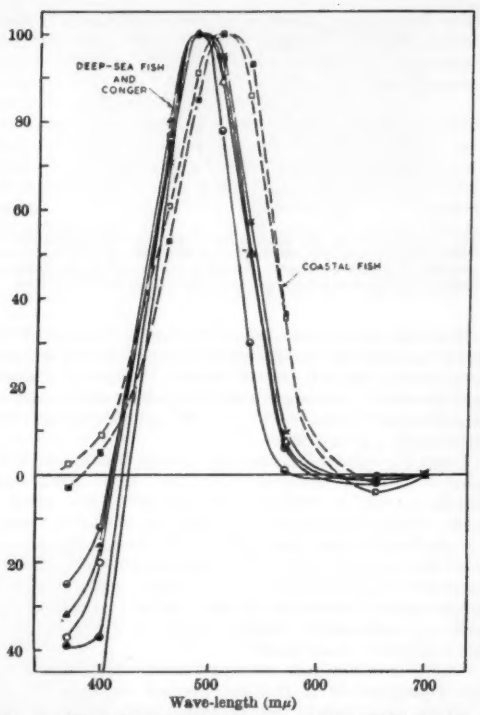

Fig. 1. The curves are of spectral density change of fresh retinæ when bleached with white light. Four deep-sea fish: ×, *Stomias boa* (Risso); ●, *Flagellostomias* sp.; ◒, *Argyropelecus olfersii* (Cuvier); ▲, *Myctophum punctatum* Rafinesque. A migrating fish: ○, *Conger vulgaris*. Two coastal fish: □, *Scophthalmus rhombus*; ■, *Cottus bubalis*. The ordinate is change in density (expressed as a percentage); the maximum density change is made equal to 100 per cent

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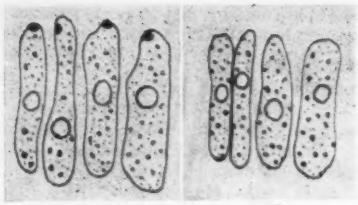
Sex Determination in Rats (*Rattus norvegicus* var. *albinus*) through the Ameloblasts of the Dental Germ

Since 1949, Barr *et al.* and others[1–3] have described the presence of 'sex chromatin' in various tissues of several animal species, arriving at the conclusion that in all of them behaviour of this 'sex chromatin' was practically identical. They excluded, however, certain rodents and lagomorphs, since it was impossible to determine their sex from nuclei of the tissues studied.

The importance of these studies became apparent when Barr[4] and Decourt *et al.*[5] applied these concepts to the determination of sex in human pathology.



(a) (b)

Fig. 1. (a) Nuclei in the adamantine epithelium of a female rat. They contain the 'sex chromatin' at the pole of the nucleus nearer to the growing enamel (Feulgen); (b) nuclei in the adamantine epithelium of a male rat, where no 'sex chromatin' is found (Feulgen)

Barr admitted that 'sex chromatin' consisted of the heterochromatic portions of the sex chromosomes. A new hypothesis[3], based on the studies of Pavan and Breuer[6,7], was suggested to explain the morpho-physiological behaviour of the chromosomes of *Rhynchosciara angelae*.

With the view of extending the application of this method of sex determination to other fields, we decided to study the 'sex chromatin' of the ameloblasts in the dental germs of one-day old albino rats.

Ten females and ten males were used. The heads were fixed in 10 per cent formalin buffered to *p*H 6·9. Frozen frontal sections, 15–20μ thick, were obtained at the level of the first molars. After prolonged and repeated washing in distilled water, they were stained by Feulgen's technique.

The sex of the rats was previously determined by the examination of the ano-genital distance.

From each head, five sections were studied. In each section, one hundred ameloblasts were studied, that is, five hundred cells per animal.

In 89·8–91 per cent of the nuclei of the ameloblasts from the females, a chromatin mass was found, almost always on the side of the growing enamel, adhering to the nuclear membrane and having on the average a diameter of 1μ (Fig. 1*a*).

A similar mass, though smaller, was found in the ameloblasts from the males, in 6·8–18 per cent of the cases (Fig. 1*b*).

The ameloblasts present a special 'chromatic pattern', differing from that of other tissues, in which the 'sex chromatin' is not easily distinguished from the other chromatin masses; this, as Barr points out, makes it difficult to determine the sex.

One of us, however, after a great many counts of the chromatin masses found in the cells examined, and based on the distribution of the various 'chromatin patterns', arrived at the conclusion that sex determination in these animals is quite possible.

At present, we are studying the determination of the sex by the examination of the ameloblasts in other animal species.

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α- and γ-Lysin Production by *R* Variants of *Staphylococcus aureus*

It was shown[1] that *R* variants of *Staphylococcus aureus* differ from *S* in producing more coagulase; this led to an investigation of other biological properties of the two variants.

The present communication concerns the production of α- and γ-lysin of the variants. β-Lysin was studied only qualitatively and δ-lysin not at all.

Ten coagulase-positive strains of human and animal origin were used: all were laboratory strains kept on artificial media for periods of upwards of one year; they differed quantitatively in production of α-lysin: four of the ten produced β-lysin. The strains included the well-known coagulaes-producing strain Newman (Duthie), two α-producing strains *C* 13 and *C* 16 (Elek) and strain 5664 (N.C.T.C.) the strain on which γ-lysin was originally described by Smith and Price[2].

Whereas one strain showed the presence of *R* variants on isolation and strains 5664 and 3917 (Burroughs Wellcome) gave an almost pure growth of *R* colonies on direct plating of the stock cultures, *R* variants of the remaining seven strains were obtained only by plating old broth cultures on chocolate agar[1]. The morphology of the colonies ranged from irregularity in outline to frank roughness. The rough character of the colonies was emphasized by growth on agar containing 0·5 per cent 'Dispersol *L-N*' (Imperial Chemical Industries, Ltd.).

The hæmolysins were prepared from *R* and *S* variants by Burnet's method[3], that is, by incubation on semi-solid media in a mixture of carbon dioxide and air; high yields of α- and γ-lysin were obtained in 24 hr.

Since both α- and γ-lysins are estimated by lysis of rabbit red blood cells, difficulty is often experienced in determining the presence and titre of one of the lysins when both are present. The difficulty was circumvented by using pure anti-γ and anti-α sera respectively. The anti-γ serum was obtained by immunization of a rabbit with the lysin of an *R* variant (5*R*) known to produce γ-lysin to a high titre and only traces of α-lysin; at the dilutions at which this serum was used only anti-γ was present. The anti-α serum was obtained by removing from an anti-α and anti-γ serum the anti-γ fraction by flocculation; the method is a slight modification of the one suggested by Marks[4].

It was found that all *R* variants were poor α-lysin producers; the α-lysin titres, expressed as the reciprocals of the highest dilutions of culture fluids showing lysis, ranged from traces to a maximum of 500: their γ-lysin titre was relatively high and ranged from 256 to 1,000. The *S* variants encountered fell into two types: one hæmolytically inactive, the other one producing the same amount of γ-lysin as the *R* variants but with higher α-lysin titres (ranging from 500 to 16,000). It was noticed that in the strains examined β-lysin was produced by both *S* and *R* variants or by neither.

If conclusions are permissible from the limited number of strains studied, *R* variants appear to be characterized by total or partial loss of α-lysin production without loss of γ-lysin. It also appears that *R* variants of suitable strains may in future be used in order to obtain good yields of γ-lysin free of α- and β-lysins.

I wish to thank Dr. E. S. Duthie and Dr. S. D. Elek for strains, Dr. Francis and Miss Mollie Barr

of the Burroughs Wellcome Research Laboratories for strains and antisera, and Dr. J. Marks for antisera.

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An Electron Microscopic Study of the Ground Substance of Connective Tissue

GROUND substance has been studied by histochemical, physiological and pharmacological methods. This communication reports some electron microscopic observations made on experimentally induced changes in ground substance. A technique is described for the study of ground substance with the electron microscope.

Cuticles of subcutaneous loose connective tissue of treated and untreated mice are spread on electrolytic copper specimen screens, air-dried, shadowed with uranium, and observed with an *RCA* electron microscope (Model *EMU*) in accordance with standard procedures[1]. No artificial supporting membranes, enzymes or chemicals are used.

Animals employed in these experiments are *CBA* mice 12–16 weeks old, grouped as follows: (1) untreated control; (2) adrenalectomized; (3) stressed by excitement or starvation; (4) locally inflamed by mechanical irritation 2 hr. prior to killing; (5) injected subcutaneously with (*a*) 0·25 mgm. hydrocortisone 12 hr. before killing, (*b*) 0·25 mgm. deoxycorticosterone 12 hr. before killing, (*c*) 60γ heparin 30 hr. before killing, or (*d*) 35 T.R. units of hyaluronidase 3 hr. before killing.

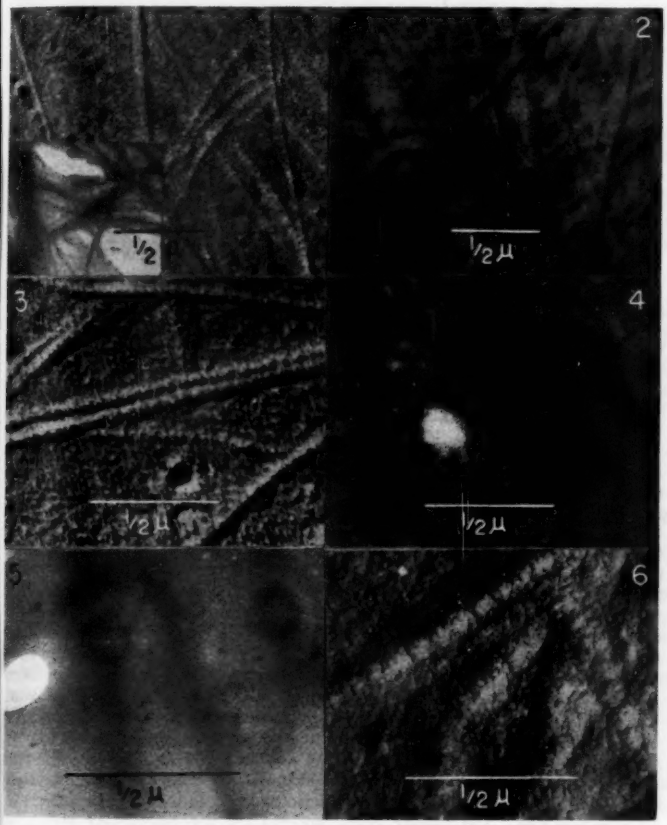
The controls used are untreated intact *CBA* mice, the connective tissue of which is removed in the same manner as in the experimental groups, described above. The time intervals selected for observation of changes following treatment are the same as those successfully used in studies of inflammatory response, as well as other histochemical studies carried out in this laboratory.

Shadowing with uranium reveals the surface morphology of ground substance, though in most cases it obscures the finer fibrillar network (Figs. 1, 1*a*). In the untreated controls the shadowed ground substance appears finely granular. The ground substance of the intact stressed (but not adrenalectomized) animals, and of those treated with hydrocortisone, is strikingly tufted and granular in appearance (Figs. 3 and 6). This tufted character is attributed to evenly distributed, uniform granules about 100 A. in diameter. Marked similarity is observed in the appearance of the ground substance in the groups treated with hyaluronidase or deoxycorticosterone and in the adrenalectomized or locally inflamed groups (Figs. 4 and 5). In these four groups the ground substance appears smooth, agranular, and homogeneous, whereas treatment with heparin increases the fibrous elements (Fig. 2).

In the groups treated with corticosteroids, irregularly shaped particles or crystalloids having diameters of 4,000 A. or less are observed in or on the matrix of the ground substance (Fig. 4).

It has been reported that cortisone and adrenocorticotropic hormones cause a decrease in the permeability of ground substance, while adrenalectomy, deoxycorticosterone and hyaluronidase induce an increase in permeability[2].

The hypothesis that changes in the physical and physiological behaviour of ground substance result from changes in its degree of polymerization[3] may be utilized to explain the morphological alterations shown here. Since hyaluronidase, deoxycorticosterone and



Electron micrographs of intercellular elements of subcutaneous connective tissue of mice. All are shadowed with uranium except Fig. 1*a*, which is non-shadowed.

(1) Untreated control. ×27,000. (1*a*) Same as Fig. 1, but non-shadowed. (2) Treated locally with heparin. ×27,000. (3) Treated locally with hydrocortisone. ×40,000 (similar to that of intact stressed group). (4) Treated locally with deoxycorticosterone. ×40,000 (similar to that treated with hyaluronidase). (5) Adrenalectomized for 24 hr. ×40,000. (6) Stressed for 30 min. ×60,000

adrenalectomy cause a marked increase in the permeability of ground substance and produce a strikingly similar morphological appearance, it is assumed that this appearance is that of 'depolymerized' ground substance. By comparison, the tufted appearance of ground substance produced by hydrocortisone treatment is apparently due to an increase in its degree of polymerization.

The morphological alterations in the surface of the ground substance may be explained on the basis of the resolving power of the electron microscope, which is, at best, about 10 A. Highly 'polymerized' components of ground substance consist of macromolecules, resolvable by the electron microscope, which give to the ground substance its characteristic granular appearance. In the 'depolymerized' state, on the other hand, the ground substance appears smooth and agranular because presumably it is composed of smaller molecules or structures which cannot be resolved by the electron microscope.

The increase in fibrous elements induced by heparin treatment may be explained by the possible influence of this drug on the precipitation of 'procollagen', which is reported to exist in soluble form in the intercellular matrix of connective tissue.

A detailed report of this work, which was supported by the United States Department of the Army Grant No. *DA*-49-007-*MD*-130, and a grant from the Armour Laboratories, is in preparation for publication elsewhere.

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Koch's Postulates applied to the Micro-ecology of Fungi inhabiting Root Surfaces

While Koch's postulates have frequently been applied for the demonstration of the pathogenic status of a fungus attacking plant organs, so far as we are aware these postulates have not been applied to the solution of problems of the micro-ecology of root-surface inhabiting fungi. This communication is presented in the hope that the method may be of interest to workers in the field of rhizosphere studies.

Investigations carried out in this Department of the incidence of fungi inhabiting the root-surfaces of numerous plants, employing the washing technique of Harley and Waid[1], have shown that sterile mycelial hyphæ of species of *Pythium* and of *Rhizoctonia solani* grow out from the surfaces of washed roots within the first 18–36 hr. of incubation at 25° C. Such fungi are considered to grow over the root surfaces. It was decided to examine the degree to which a strain of *Rhizoctonia solani* isolated from washed roots of *Taraxacum officinale* would colonize the root surfaces of a series of plants and could be recovered from such root systems.

An inoculum was prepared by allowing sterile, single cotyledons of garden pea to become thoroughly infected by incubating the cotyledons on actively growing cultures of the strain of *Rhizoctonia*. Air-dried soil, screened to pass a ¼-in. sieve, was adjusted to a water-holding capacity of 60 per cent, packed into glass tumblers, covered with 'Cellophane', and steamed for 45 min. It was allowed to stand for one week before inoculation and transplantation of the test seedlings. Such steaming reduces the soil microflora without effecting complete sterilization. Seedlings of lettuce, onion, pea, tomato, barley and oat were grown from seed and grain, surface-sterilized for one hour in calcium hypochlorite solution, washed in sterile water and incubated at 25° C. Three seedlings of each species were transferred to each tumbler of steamed soil and for each species three tumblers were inoculated with infected pea cotyledons and two were kept as uninoculated controls. During the subsequent three weeks of incubation the water content of tumblers was maintained by periodic addition of sterile tap water.

On harvesting, the roots of each group of seedlings were shaken free of loosely attached soil, vigorously washed in three changes of sterile tap water and transferred to a sterile Petri dish. Five pieces of root each 1 cm. long were selected at random from each group and plated on plain water agar. Table 1 sets out the degree of recovery, after 22 hr. incubation at 25° C., of *Rhizoctonia* in one set of experiments. Mycelium was recovered from some of the root pieces of the control plants but did not belong to *Rhizoctonia*. Repetition of these experiments gave entirely comparable results.

Table 1. Recovery of *Rhizoctonia solani* from Root Systems growing in Inoculated Soil

Root pieces	Species					
	Barley	Lettuce	Oat	Onion	Pea	Tomato
1	1	2	3	2	0	4
2	2	2	3	1	0	3
3	2	1	4	3	2	4
4	0	0	4	0	1	2
5	2	2	4	0	0	3

Figures represent the abundance of hyphæ growing from each root piece, 4 being the maximum score.

Since the experimental soil had been steamed and not sterilized, colonization of root systems was effected against a certain degree of competition but against much less than would have been the case in normal field soil. The results demonstrate that a fungus repeatedly isolated from the surfaces of thoroughly cleansed roots can be recovered from the root surfaces of seedlings growing in soil inoculated with that species under conditions of minimal competition from normal soil saprophytes. They also indicate that fungi, isolated from root surfaces when introduced into soil with a reduced microflora, find their ecological niche on the surface of root systems growing through such soil. In these experiments there was no evidence of preferential selection of root surfaces in relation to the higher plant species by the particular strain of *Rhizoctonia solani*. Inasmuch as this fungus has been repeatedly isolated from washed root surfaces, has been inoculated into steamed soil in which seedling roots have been growing, and has been recovered from vigorously washed root surfaces of a series of root systems, the experiments described

represent an application of Koch's postulates to the micro-ecology of the fungal flora of root surfaces.

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Root Exudates of Paddy

THE importance of studying root exudates in understanding the behaviour of the rhizosphere microflora is now well recognized. Many techniques have been evolved for collecting root exudates under non-sterile conditions without regard to the attendant injury to root system and with the consequent sloughing off of the root cortex[1]. This communication records an attempt to overcome these defects in technique by collecting the exudates under sterile conditions, during the first week of the growth of the plants.

Two strains of paddy, one resistant (*GEB*.24) and the other susceptible (*MTU*.9) to the 'foot-rot' disease caused by *Fusarium moniliforme* were used as test plants. Two superimposed filter papers (Whatman No. 1) of approximately 8 cm. diameter were placed in 'Pyrex' flasks, moistened with 1/10 *N* Richard's solution without sucrose (prepared from 'Analar' salts and 'Pyrex' glass-distilled water) and sterilized at 15 lb. pressure for 15 min. Fifty seeds, surface sterilized and washed with several changes of glass-distilled water, were germinated under sterile conditions and transferred aseptically to each flask. After five days growth at room temperature (30–32° C.), the plants were carefully removed without leaving any rootlets on the filter papers. The possibility of bacterial or fungal contamination of the test plants was checked at every stage by plating and microscopic examination. The filter papers were finely ground with 80 per cent alcohol, the extract centrifuged and the supernatant concentrated for analysis.

The technique of ascending chromatography of Williams and Kirby[2] as modified by Lakshminarayanan[3] for unidimensional chromatograms was used to study the constituents of the exudates positive to ninhydrin employing *n*-butanol/acetic acid/water (4 : 1 : 5) as the solvent mixture. As anticipated, several free amino-acids were present in the root exudates of both the resistant and susceptible strains. Their relative concentrations in each exudate were determined by visual observation of the intensity of the spots developing on the chromatogram (Table 1).

Table 1

Material	Amino-acids	Relative concentration	R_F-values
Resistant	Cystine	+++	0·033
	Asparagine	++++	0·073
	Aspartic acid	++	0·140
	Glutamic acid	+	0·176
	Tyrosine	+	0·320
	Methionine	+	0·376
	Tryptophan	+	0·446
	Lysine	+	0·602
Susceptible	Aspartic acid	+	0·140
	Glutamic acid	+	0·170
	Tryptophan	+	0·440
	Lysine	+	0·602

The extracts from the control flasks where no plants were grown gave negative reactions to ninhydrin.

The results indicate that the four amino-acids found in the root exudates of the susceptible strain, namely, aspartic acid, glutamic acid, tryptophan and lysine, were also present in the root exudate of the resistant strain, almost in the same concentrations. However, the latter had four other amino-acids as well, namely, cystine, asparagine, tyrosine and methionine. Of these, cystine and asparagine were exuded in high concentrations. This result is significant, especially in view of an earlier report from this laboratory on the presence of cystine in strains of cotton resistant to *Fusarium vasinfectum* wilt[4]. Such differences in the composition of root exudates of resistant and susceptible varieties have no doubt great influence on their specific rhizosphere microflora, and indeed further work in this direction appears to be a promising field of inquiry into the mechanism of resistance to root diseases in general.

We are indebted to Prof. T. S. Sadasivan and Dr. C. V. Subramanian for helpful suggestions.

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The Heterotrichous Habit in the Protonema of the Bryales

DURING recent investigations on the development in aseptic culture of a range of typical representatives of the Bryales (species of twelve genera, from six orders) we have found that the protonema possesses a more definite morphological pattern than would appear to have been appreciated previously. Examination of the advancing edge of isolated cultures growing on a solid substratum (Knop's agar or filter paper moistened with Knop's solution) has shown that in all the species studied, with the one exception of the aquatic moss *Cinclidotus fontinaloides* (Hedw.) P. Beauv., there is a striking distinction between a horizontal system of filaments creeping in or on the substratum and an aerial system of filaments arising vertically or obliquely from the horizontal system. This "heterotrichous habit", to use a term employed by Fritsch[1] for the corresponding condition in the algae, is well seen in *Funaria hygrometrica* Hedw. (Fig. 1), in which the prostrate system of a well-developed protonema is formed by stout brown-walled filaments with oblique septa and few chloroplasts, while the filaments of the aerial system, on the contrary, have hyaline walls, straight septa and numerous chloroplasts.

The relative degree of development of erect and prostrate systems, although influenced to some extent by environmental conditions, shows characteristic differences in the individual species, and some of the cultures are readily distinguished by their external

appearance. In *Funaria* the prostrate system is extensive, while the filaments of the erect system are low and fairly widely spaced; but in a number of species (*Ceratodon purpureus* (Hedw.) Brid. (Fig. 1), *Pohlia nutans* (Hedw.) Lindb., *Leptobryum pyriforme* (Hedw.) Wils., *Bryum capillare* Hedw. and *Eurhyncium riparioides* (Hedw.) Jennings) although the prostrate system is still quite extensive, the aerial system is considerably better developed than in *Funaria*. The erect branches arise close together in this group of species and frequently become intertwined to form vertical tufts which rise from the medium like a miniature forest of pine trees. In *Pleuridium acuminatum* Lindb. (Fig. 1) and *Tortula muralis* Hedw. (Fig. 2) the prostrate system spreads very slowly and there is a corresponding increase in the aerial system, which undergoes an extensive development.

In all cultures, the filaments of the erect system have the characteristics of typical chloronema[1]; but those of the prostrate system are often somewhat different, and may have brown walls and oblique septa, although this distinction is not always as marked as in the case of *Funaria*. The aerial filaments are highly sensitive to light and markedly positively phototropic; but we have made no study of the factors responsible for the horizontal position of the prostrate system. A third tropic response is shown, in some of the cultures, by filaments which grow vertically downwards in the medium. These filaments have sometimes the morphological characteristics of typical rhizoids (for example, in *Ceratodon* (Fig. 1)); but frequently as in *Tortula muralis* (Fig. 2) they are merely narrower and paler than the normal chloronema filaments.

In *Cinclidotus* the growth pattern of the protonema differed considerably from that found in the other genera, and on all media the spores gave rise to compact, dark-green more or less globular masses which were formed from markedly short-celled irregularly branched filaments. Since the cultures produced numerous buds and leafy shoots, it is not unlikely that even under natural conditions the protonema of *Cinclidotus* may show a similar anomalous development.

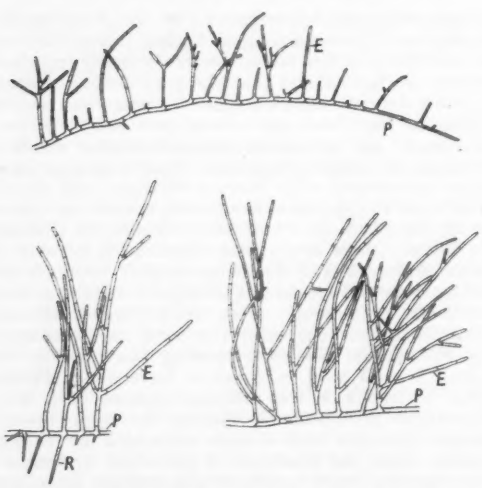

Fig. 1. Portions of protonema from cultures of *Funaria hygrometrica* Hedw. (top), *Ceratodon purpureus* (Hedw.) Brid. (bottom left) and *Pleuridium acuminatum* Lindb. (bottom right). Cultures grown in 100 ml. Erlenmeyer flasks on half-strength Knop's solution, with 0·5 per cent agar. *Funaria* and *Pleuridium* grown under artificial light (500 foot-candles) *Ceratodon* in natural daylight. *E*, Erect branches; *P*, prostrate system; *R*, rhizoidal branch. (*Funaria* × *c.* 15; *Ceratodon* and *Pleuridium* × 23)

Fig. 2. *Tortula muralis* Hedw. Photograph of vertical slice through culture grown on half-strength Knop's solution with 1 per cent agar in culture tube under artificial light (500 foot-candles). Prostrate system, not clearly shown, lies between the stouter branches of the aerial system and the thinner branches penetrating downwards into the medium (× 64)

The course of bud formation was followed in detail in all the species in culture. Various arrangements of the buds were observed; but in most species the buds developed singly towards the base of the aerial filaments.

Although the heterotrichous habit is more marked in a well-grown protonema than in the earliest stages following spore germination, we have found no evidence of a distinct *caulonema* or bud-bearing stage of the kind described by Sironval[3] for *Funaria*. Sironval claimed that exposure to natural daylight is necessary for the formation of caulonema and consequently of moss buds; but in all our cultures buds were formed as readily in artificial light (500 ft.-candles) as in natural daylight.

We are indebted to Mr. G. Barker for the photograph reproduced in Fig. 2.

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Crossing of Two Allopatric Populations of *Culex fatigans* Wiedemann

Two colonies of *Culex fatigans* are maintained in the insectary: one from Lagos, the other from British Guiana (obtained through the kindness of Dr. L. J. Charles). The two strains were subject to a preliminary taxonomic examination and to experimental crossing.

There was no difference in the morphology of adults or pupæ of the two strains. There was no constant difference in the morphology of the 4th instar larvæ except for the presence of black tips on the anal papillæ of larvæ from British Guiana. Larvæ of both strains had the same survival threshold (9/1,000) when subjected to a salinity test with sodium chloride.

Two colonies were set up: British Guiana males with Lagos females and British Guiana females with Lagos males. The resulting generations were about equal in number. The F_1 generation from British Guiana mothers showed black-tipped anal papillæ in 80·0 per cent of examined larvæ. None of the F_1 generation derived from Lagos females possessed this character. Both these populations were selfed. The F_2 generation from British Guiana females had 100 per cent frequency of black-tipped anal papillæ, while none of the other F_2 generation possessed this character. On further selfing this character disappeared, however, and remained absent in further generations.

The two populations of *C. fatigans* are conspecific judging from the ease with which fertile hybrids were produced. There are, to our knowledge, no other records of experimental crossing of two allopatric populations of *C. fatigans*.

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Pugnacity of Marlins and Swordfish

From a wide area of the sea there have been reported occasional incidents illustrating the pugnacity of marlins and swordfish. This has been supported by recent evidence from South African seas, as a result of the Second World War, when a number of ships from the East were torpedoed in the Mozambique Channel. From these vessels quantities of bales of rubber were left floating awash, and from that time many thousands have continually been stranded, over an enormous stretch of the coast of South and East Africa. A good many bales must have remained in eddies, since even to-day they continue to come ashore. It was soon noticed that many bales contained the tips of spears of marlins, and it now appears that the longer a bale remains in the sea the more broken spears it is likely to contain, for those cast ashore in recent times have held as many as four. Most of these residues have been the tips broken near the front of the spear.

Marlin must deliberately charge floating or submerged objects, intending to impale them, possibly to secure food, but possibly also from plain aggressiveness. Almost all the spear tips found have been small, indicating marlins of 5–8 ft. in length, most found 4–6 in. within the bale, indicating very considerable penetrative force. This might suggest that small marlins are more aggressive than larger fishes; but it may equally be argued that the very much more densely ossified stout spear of the large fish would be less likely to break at any point, so that larger fish would have more hope of withdrawal. That large marlins also have this habit is indicated clearly by a bale recently found, in which was found embedded, to a depth of 13 in., virtually immovable, the apical 24 in. of the stout spear of a black marlin that could not have been less than 11 ft. in length with a weight of probably 400 lb. It is clear that to drive so stout a spear into a floating bale of resistant rubber so deeply, the fish must have been moving at great speed. It is equally clear that it must have taken very great force to break so stout a spear near its base in the skull, and the clue to what had happened was furnished by some teeth of a large shark (probably *Carcharinus*) also found embedded in the same bale. This marlin paid dearly for its pugnacity. Hampered by the heavy bale in that position, it would neither be able to withdraw the spear nor break so stout a bony rod. Its struggles must soon have attracted sharks, abundant in East African seas, that in increasing numbers would rapidly have torn it to pieces and become blood crazed in the process. In the mêlée one of them must have seized the bale of rubber and it was doubtless this that provided the extra force needed to fracture the stout spear. It was from this chance that the bale in question still retained sufficient buoyancy to reach the shore. In most such cases the weight of the severed head or of the skull of a large marlin would cause the bale to sink.

In one bale was also found the undoubted sword of the broadbill swordfish (*Xiphias*), indicating a similar habit for that species.

It was from this evidence that I had earlier come to believe that marlin were abundant in south-east African seas, as has been amply proved in recent times.

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Light Energy and Brightness Sensation

Engineering problems demand a knowledge of the relation between energy stimulus and the resulting sensation. In the field of acoustics, scales of 'loudness' have been derived which are of engineering value.

In the field of lighting and vision, the derivation of scales of apparent brightness is made more difficult by the influence of adaptation and simultaneous contrast. The sensation which is given by a patch of given luminance (physical brightness) depends not only on the energy emitted from the patch but also on the luminances of the neighbouring parts of the field of view. Abribat[1] showed how a scale of apparent brightness, which took adaptation into account, could be derived from just noticeable differences. Data obtained by Pitt[2] using a binocular matching technique enabled scales of apparent brightness to be drawn up independent of the questionable Fechner integration. Hopkinson[3] derived a scale of apparent brightness from supra-threshold contrast judgments.

A new set of determinations of apparent brightness has recently been completed for a limited number of observers, following a discussion with Prof. S. S.

Stevens of Harvard University. The results are of interest in that they show certain affinities with and certain differences from the 'loudness' scales referred to above. In these determinations, direct estimations of brightness were made both of an adapting field covering 120 deg. and of a 2 deg. patch the luminance of which could be independently adjusted. The method used was similar to that described by Stevens[4]. Among the conclusions which can be drawn from the results are:

(1) The relation between the physical luminance of the 2-degree field alone and the resulting sensation of brightness follows approximately but not exactly the relation,

$$M = kL^{0.3}$$

where M is the magnitude of brightness sensation as judged by the subject and L is the physical luminance of the 2-degree field.

(2) When the 2-degree patch is seen in the adapting field, the exponent of L varies with the luminance of the adapting field, increasing from 0·3 in a dark field to 1·0 at an adapting luminance of 450 foot lamberts.

(3) At high adaptation-levels, therefore, brightness sensation as determined by direct judgment bears a linear relation to physical luminance. Two luminances which appear the one 'twice as bright' as the other are actually related, at high adaptation-levels, by the ratio of two to one in luminance whereas when seen in dark surroundings they are related more nearly by a ratio of 10 : 1 luminance.

These conclusions agree with those derived from the supra-threshold contrast data[3] although there are significant differences between some of the data.

The relation $M = kL^{0.3}$ is precisely the relation which Stevens and others have published for the relation between loudness and sound energy-level.

The third conclusion appears to be new, and to have no counterpart in the field of sound. On the other hand, most of the systematic loudness judgments were made in anechoic rooms, which might correspond to the visual condition of 'dark surround'.

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Mutarotation of Poly-L-proline

The synthesis and some of the properties of poly-L-proline were described recently[1]. A sample with an average degree of polymerization $n = 67$ which was obtained by bulk polymerization, dissolved in glacial acetic acid and precipitated with ether, gave the following specific rotations: $[\alpha]_D^{20}$ −483° (*c.* 1·5 in formic acid), $[\alpha]_D^{25}$ −372° (*c.* 2·0 in glacial acetic acid) and $[\alpha]_D^{25}$ −353° (*c.* 2·0 in water). As will be shown however, the optical rotation of a solution of poly-L-proline depends both on the history of the sample and on the manner in which the solution was prepared.

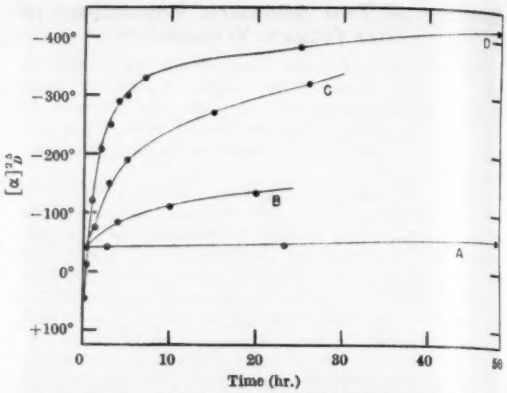

Fig. 1. Mutarotation of poly-L-proline (average degree of polymerization $n = 75$) in pyridine–water mixtures at 25° C. The solutions were obtained by diluting 1 ml. of the original pyridine polymerization mixture to 10 ml. with pyridine and water. Curves *A*, *B*, *C* and *D* give the mutarotation in solutions containing 10, 20, 30 and 90 per cent by volume of water, respectively

N-Carboxy-L-proline anhydride[1] (5 gm.) was polymerized in pyridine (50 ml.) for three days at room temperature. Dilution of 1 ml. of the polymerization mixture with 9 ml. pyridine gave a clear solution with $[\alpha]_D^{25}$ −24°. The optical rotation of this solution did not change for several days at room temperature. A solution obtained by dilution of 1 ml. of the polymerization mixture with water to a volume of 10 ml. showed a rapid change in optical rotation with time. Within 50 hr. at room temperature the specific rotation changed from $[\alpha]_D^{25}$ +48° (2 min. after mixing) to $[\alpha]_D^{25}$ −420° (Fig. 1, curve *D*). Curves *A*, *B* and *C* show the change of the optical rotation with time in different pyridine-water mixtures. Fig. 1 demonstrates that the rate of mutarotation increases with the concentration of water in the medium.

When poly-L-proline was precipitated from the pyridine polymerization mixture with ether a white powder was obtained which was insoluble in pyridine, only partly soluble in water, and readily soluble in formic acid and acetic acid. An average degree of polymerization $n = 75$ was derived from end-group analysis. The change of the optical rotation with time at room temperature of the precipitated material

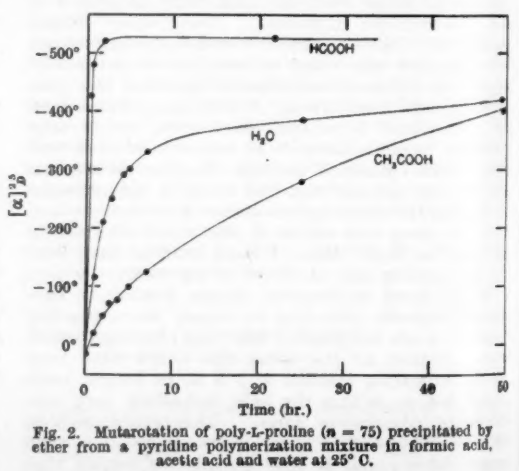

Fig. 2. Mutarotation of poly-L-proline ($n = 75$) precipitated by ether from a pyridine polymerization mixture in formic acid, acetic acid and water at 25° C.

dissolved in formic acid, acetic acid and water is shown in Fig. 2. Mutarotation in glacial acetic acid solution was also observed in a poly-L-proline preparation obtained by polymerization in dioxane using triethylamine as initiator.

When the poly-L-proline sample obtained from the pyridine polymerization mixture by ether precipitation was dissolved either in hot glacial acetic acid or in metacresol at 100° C. and reprecipitated from the cooled solutions by ether, it was found to dissolve readily in water. It gave $[\alpha]_D^{25} -500°$ (*c.* 0·5 in water), $[\alpha]_D^{25} -450°$ (*c.* 0·5 in glacial acetic acid) and $[\alpha]_D^{25} -525°$ (*c.* 0·5 in formic acid).

In seeking an explanation of the above phenomena, a change in the chemical structure of poly-L-proline under the conditions leading to mutarotation can be ruled out. This is supported by the observation that all the forms of the polymer, on acid hydrolysis, yielded L-proline quantitatively. It seems reasonable therefore that the change in optical rotation is due to a change in the spatial configuration of the macromolecule, connected possibly with a *cis–trans* transformation in the amide bond.

A helical structure based on the *trans*-form of the amide linkage was established for the highly lævorotatory form of poly-L-proline by Cowan and McGavin[2] from the X-ray diffraction pattern given by oriented films of this polymer. It seems likely that the molecules of the highly lævorotatory form of the poly-L-proline have a similar helical structure also in water, acetic acid and formic acid. The poly-L-proline obtained in pyridine as described above probably represents an unstable form which changes into the more stable form under the influence of formic acid, acetic acid or water.

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Solubility of Albumin in Alcohol after Precipitation by Trichloroacetic Acid: a Simplified Procedure for Separation of Albumin

RADIOACTIVE proteins are prepared for counting in many laboratories[1-3] by slight modifications of the basic technique of precipitation with 10 per cent trichloroacetic acid, several washes with 5 or 10 per cent trichloroacetic acid, treatment with hot alcohol, hot alcohol–ether and drying with ether. When it is required to remove nucleic acids, the protein is treated with 5 per cent trichloroacetic acid at 90° for 15 min. before the hot alcohol wash.

During an experiment in which rat serum proteins were being prepared for counting, we noticed that some of the protein precipitated by trichloroacetic acid dissolved in the absolute alcohol. We have observed this phenomenon repeatedly while preparing other samples for counting, but only if albumin is one of the proteins present. Albumin is also soluble in other solvents (acetone, ether) after precipitation by trichloroacetic acid and continues to be soluble even if higher concentrations of the acid are used to precipitate the protein. The precipitated albumin is only soluble in alcohol or the other solvents if a small amount of acid is present. Trichloroacetic, hydrochloric and acetic acids all work well in this respect. Treatment with 5 per cent trichloroacetic acid at 90° for 15 min. did not entirely prevent the albumin from dissolving in the absolute alcohol.

If the proteins are boiled, albumin will no longer dissolve in the acid-alcohol. It seemed possible that precipitation by trichloroacetic acid did not denature the albumin. Rat serum was therefore precipitated with 10 per cent trichloroacetic acid, centrifuged, the acid poured off and absolute alcohol added. (The drop of acid remaining in the pellet is sufficient acid for our purpose.) The pellet was stirred and the undissolved protein spun down and the clear supernatant dialysed against distilled water for 24 hr. The dialysate was lyophilized and the dry protein powder examined. All the dry protein obtained by this means dissolved readily in water. Paper electrophoresis in 0·05 *M* veronal buffer at *p*H 7·4 and at *p*H 8·6 resulted in a single spot which was unretarded when compared with rat serum albumin separated by the Cohn procedure[5] and with the albumin spot of rat serum. Addition of rabbit serum immunized with rat serum albumin produced precipitation of our albumin from the solution whereas rabbit serum without antibody caused no precipitation. The protein obtained by the method outlined appears to be undenatured rat serum albumin. Preliminary experiments indicate that the albumin is not contaminated by other proteins. Similar findings were obtained with bovine albumin and human serum albumin.

We believe this simple procedure offers the basis for a rapid separation of serum albumin and a method for the detection and quantitative estimation of albumin in mixtures of other proteins, and we expect to publish full details of such methods at an early date. Meanwhile, we point out the necessity for care when preparing proteins for counting by the conventional techniques, especially if they contain albumin.

This work was supported by grants awarded to Dr. H. Tarver from the American Cancer Society.

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Molecular Weight Determination of Components by Gas-Phase Chromatography

THE gas-density balance apparatus developed by Martin and James[1] for detection and estimation of components in gas-phase chromatography might be used for a rapid process for evaluating the molecular weights of single components.

It has been shown that in a detector, which makes use of a gas-density balance, if the densities of two gas streams coming out of two columns, one where

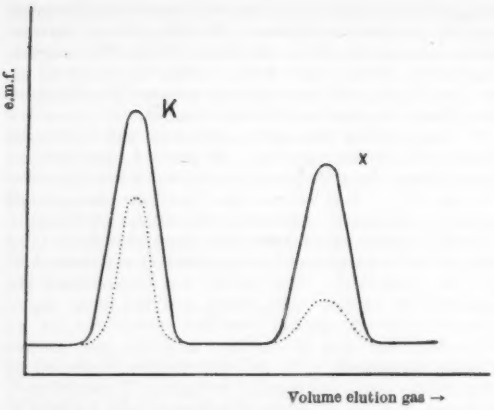

Fig. 1. Schematic diagram of a gas phase chromatogram of a mixture of a known (K) and an unknown (x) component. Heavy line, elution gas M_1; dotted line, elution gas M_2

the separation is achieved, the chromatographic column, and the other acting as a reference column, are continuously compared, the difference in density between the two gas streams can be converted into an electromotive force in a sensitive thermocouple.

The suggested procedure consists of the addition to the unknown mixture of a pure substance of known molecular weight, which is defined as the 'internal standard', and in running a chromatogram of the mixture on the same column by using two different elution gases.

To the unknown mixture, which for simplicity is assumed to consist of only one compound, x, the molecular weight of which is M_x, the 'internal standard' K (mol. wt. $= M_K$), is added and the chromatogram of the mixture by using as elution gas a gas (mol. wt. $= M_1$), will appear as in Fig. 1 (heavy line).

By replacing as elution gas one with a different molecular weight (M_2), the chromatogram will be as in Fig. 1 (dotted line). If the gas flow is kept constant, the volume of elution gas will be the same for both components; peak heights and areas will be, however, different for the different elution gases and for the different size of the sample analysed, which does not need to be known.

The density of the gas at the outlet of the reference column (reference gas: d_1) and at the outlet of the chromatographic column, when component x passes through the detector, (d_x), can be expressed in terms of the gas law equation:

$$d_1 = \frac{M_1 P}{RT} \qquad d_x = \frac{(n_1 M_1 + n_x M_x)P}{RT} \qquad (1)$$

where n_1 and n_x are the mole fractions and M_1 and M_x the molecular weights of the elution gas and of the unknown component.

The density difference between the two gas streams in the detector Δd_{x-1} is:

$$\Delta d_{x-1} = \frac{n_x(M_x - M_1)P}{RT} \qquad (2)$$

A similar expression is obtained by eluting with a gas of a different molecular weight, M_2:

$$\Delta d_{x-2} = \frac{n_x(M_x - M_2)P}{RT} \qquad (3)$$

The amount, Q_x, of the compound, x, which was chromatographed in run A can be expressed in terms of the volume of the gas mixture, v, coming out of the chromatographic column:

$$Q_x = \int_0^\infty \frac{n_x M_x P}{RT}\, dv$$

and by substitution of n_x value from (2)

$$Q_x = \frac{M_x}{M_x - M_1}\int_0^\infty \Delta d_{x-1}\, dv$$

The amount, q, of the compound, K, chromatographed in the same run A is given by a similar expression:

$$q_K = \frac{M_K}{M_K - M_1}\int_0^\infty \Delta d_{K-1}\, dv$$

where Δd_{K-1} is the density difference between the two gas streams when component K passes through the detector.

Similar expressions are obtained for amounts Q'_x and q'_K of compounds x and K chromatographed in another run, B.

It has been demonstrated that the e.m.f., E, of the thermocouple in the detector is proportional to the density difference at least for small density changes; this condition is fulfilled providing the sample size is in the range of a few microlitres as it is usually in gas-phase chromatography work. The integrals may be easily solved by taking:

$$\int_0^\infty \Delta d\, dv = K\int_0^\infty \Delta E\, dv$$

Experimentally Q_x, $Q'_{x'}$, q_K and q'_K cannot be directly measured with a high degree of accuracy; but since the ratio $\frac{Q_x}{q_K}$ is equal to $\frac{Q'_x}{q'_K}$ by combining the above-mentioned expressions and measuring the corresponding surface of the peaks A_x, a_K, $A'_{x'}$, and a'_K obtained in the automatic graphical registration of the chromatograms, in arbitrary units, the following expression is obtained:

$$\frac{A_x}{a_K}\left(\frac{M_K - M_1}{M_x - M_1}\right) = \frac{A'_x}{a'_K}\left(\frac{M_K - M_2}{M_x - M_2}\right)$$

which can be easily solved in terms of M_x.

This expression is valid providing the gas flow is kept strictly constant and the density changes are small.

For example, in a set of experiments carried out with a conventional apparatus using chromatographic columns, thermostated at 132°, filled with 'Celite' with which tricresylphosphate as stationary liquid was mixed, a known compound (ethylbenzene $M_K = 106{\cdot}2$), used as internal standard, was mixed with a hydrocarbon of unknown molecular weight (dodecane $= M_x = 170{\cdot}3$, nitrogen $(= M_1)$ and hydrogen $(= M_2)$ were used as elution gases; areas were measured in arbitrary units).

The following results have been obtained:

$\left[\frac{A_x}{a_K}\right]$	$M_1 = N_2$	$\left[\frac{A'_x}{a'_K}\right]$	$M_2 = H_2$	M_x
2·24		2·06		
2·25	Average	2·04	Average	
2·28	2·27	2·04	2·03	163
2·30		2·00		

The theory has been checked on many compounds in vapour-phase partition chromatography by using

as elution gas hydrogen, nitrogen or carbon dioxide. By taking a convenient standard, an accuracy of about 4 per cent can be obtained.

Details of the apparatus, of the experimental data and the calculations will be published elsewhere.

One of us (A. L.) is greatly indebted to Dr. A. J. P. Martin and to his staff of the Medical Research Council for information and advice given to him in the building of the gas-density balance meter.

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An Unexpected Catalytic Dehydrogenation

During the course of an investigation which is being made on the decomposition of amines in the presence of hydrogen over evaporated metal-film catalysts, an unexpected example of selective catalytic action has been observed. The decomposition of cyclohexylamine on evaporated platinum films at 134° C. was expected to produce cyclohexane and ammonia according to the equation

$$C_6H_{11}NH_2 + H_2 \rightarrow C_6H_{12} + NH_3 \qquad (1)$$

The reaction was followed by continuous mass-spectrometric analysis of the reacting gases by a technique described elsewhere[1]. As the ions of mass 99 ($C_6H_{11}NH_2^+$) decreased in number, ions of mass 17 (NH_3^+) appeared but very few ions of mass 84 ($C_6H_{12}^+$) were observed. A search throughout the mass-range covered by the spectrometer indicated that large quantities of ions of mass 78 were being produced, suggesting that the primary product of the reaction was benzene (C_6H_6) rather than cyclohexane. Now the position of the equilibrium[2] in the reaction

$$C_6H_{12} \rightleftharpoons C_6H_6 + 3H_2 \qquad (2)$$

is well over on the side of cyclohexane under the conditions used in this work. The initial reaction mixture consisted of 1·8 mm. cyclohexylamine and 23 mm. hydrogen and, assuming complete conversion according to reaction (1) and the known equilibrium constant for reaction (2), the maximum pressure of benzene to be expected at 134° C. was only about 10^{-3} mm. The identification of the source of the mass 78 ions as benzene was therefore considered tentative until it was found that when most of the cyclohexylamine was used up the ions of mass 78 began to disappear again and in turn substantial quantities of ions of mass 84 were formed. This showed that the normal catalytic hydrogenation of benzene to cyclohexane, to be expected on a metal like platinum, was then taking place. The formation of benzene was also confirmed by stopping a typical reaction and identifying the benzene in the reaction mixture by vapour-phase chromatography. The whole course of the reaction is shown in Fig. 1.

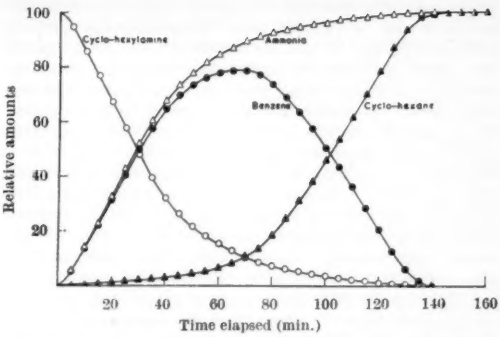

Fig. 1. Relative amounts of cyclohexylamine, ammonia, benzene and cyclohexane during reaction of 1·8 mm. cyclohexylamine and 23 mm. hydrogen on a 5·65 mgm. evaporated platinum catalyst at 134° C.

The initial reaction can be written as

$$C_6H_{11}NH_2 \rightarrow C_6H_6 + NH_3 + 2H_2 \qquad (3)$$

which is the sum of reactions (1) and (2). Although the equilibrium constant for reaction (1) is not known, it is probably of similar magnitude to that for the corresponding hydrogenation of methylamine to methane and ammonia which is approximately 10^{12} at 134° C. Combining this figure with the known equilibrium constant[2] for reaction (2), a value of 10^{18}(mm.)^2 is found for reaction (3). The magnitude of this value indicates that it is thermodynamically feasible for benzene to be formed according to reaction (3) even in the presence of a large excess of hydrogen.

The selective action of the catalyst causes reaction (3) to take place in preference to reaction (1). It is not perhaps surprising that benzene should be produced on the surface of the catalyst since it is known that saturated hydrocarbons can lose hydrogen atoms on transition metal catalysts in this temperature-range. However, it is most interesting that the presence of the amine can inhibit the hydrogenation of benzene which is usually a facile catalytic reaction. Further work is in progress to elucidate the details of this type of phenomenon in connexion with the vapour-phase decomposition of cyclic amines on evaporated metal-film catalysts and will be published in due course.

One of us (R. L. M.) is the holder of a British Celanese studentship.

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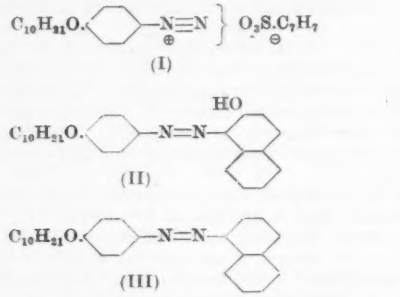
Benzene-soluble Aryldiazonium Salts

While typical salts are soluble in water and insoluble in hydrocarbons a few are soluble in both media. No member of the large and important group of diazonium salts is known to be soluble in weakly polar media, however, and this has prevented a study of the reaction of the salts with such reagents as the organometallic compounds, though their complexes with metallic salts have been used[1,2].

We have now found that *p*-*n*-decyloxybenzenediazonium toluene-*p*-sulphonate, *p*-cetyloxybenzenediazonium chloride and 2 : 5-di-*n*-*p*-decyloxybenzenediazonium chloride are all moderately soluble in warm benzene, though sparingly in the cold. The salts appear to exist in benzene as ion pairs, though

more complex association compounds of molecules and ions may be present also. Thus they react easily with β-naphthol in the same solvent, in the presence of a small proportion of pyridine (1 mole), to form normal azo-compounds. *p*-*n*-Decyloxybenzenediazonium toluene-*p*-sulphonate (I) gives 1-(*p*-*n*-decyloxyphenylazo)-2-naphthol (II), a scarlet, crystalline compound. The salts also react very readily with typical Grignard reagents. α-Naphthylmagnesium bromide and (I) give 1-(*p*-*n*-decyloxyphenylazo)naphthalene (III), though only in 10–30 per cent yield, the highest yields being obtained at 60° and the lowest at the room temperature. In addition, the reaction gives *p*-*n*-decyloxydiphenyl (IV) (25–30 per cent), *n*-decyloxybenzene (V) (5–7 per cent), and naphthalene (30–40 per cent). There was no indication of the formation of diphenyl, 4 : 4′-di-*n*-decyloxydiphenyl, 1-(*p*-*n*-decyloxyphenyl)naphthalene, 1-phenylnaphthalene, 1 : 1′-dinaphthyl, *p*-*n*-decyloxyazobenzene or 4 : 4′-di-*p*-*n*-decyloxyazobenzene.



The azo-compound (III) is the expected product of an ionic reaction between α-naphthyl anions and diazonium cations, but the formation of (IV), (V) and naphthalene appears to require the intervention of radicals.

Analogously, the same diazonium salt (I) and phenylmagnesium bromide gave *p*-*n*-decyloxyazobenzene, but the most abundant of the isolated products was *p*-*n*-decyloxydiphenyl (IV).

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Occurrence of Substances Similar to Gibberellic Acid in Higher Plants

If the fungal metabolite gibberellic acid is applied to dwarf varieties of pea, french bean (*Phaseolus*), broad bean (*Vicia*) or maize, growth is greatly accelerated and plants similar to the normal tall phenotype are produced; the tall varieties themselves are much less affected by gibberellic acid, if at all[1,2]. This suggests that this acid, or a substance with similar physiological properties, is a normal plant-growth regulator, produced less abundantly in dwarf varieties than in tall ones. The growth-promoting substance obtained from immature bean seeds by Mitchell, Skaggs and Anderson[3] was probably of this type; more recently, West and Phinney[4] have reported the probable occurrence of substances like gibberellic acid in seeds of several plant species; I have obtained evidence of such a substance in the shoots of dwarf and tall peas, and this is summarized below.

Shoots of pea seedlings grown in a greenhouse were frozen to −15° C. and broken down to a coarse powder. This was covered with ethyl alcohol and stored at 0° C. overnight. The solvent was separated by filtering and pressing the plant material. The ethyl alcohol was then distilled off *in vacuo*, and the aqueous residue was filtered and extracted with ethyl acetate at *p*H 3. This was distilled off *in vacuo* over 30 ml. distilled water in order to precipitate water-insoluble material which had been carried over; the aqueous solution so obtained was filtered and extracted with fresh ethyl acetate, which was concentrated and spotted on chromatography paper. The paper was eluted with water and the resulting eluate was acidified to *p*H 3 and extracted with ethyl acetate or ether. This was distilled off *in vacuo* and the residue was taken up in 0·25 ml. ethyl alcohol and spotted on 2-cm. wide strips of chromatography paper. These strips were run in a descending solvent system consisting of chloroform/ethanol/water/formic acid in the proportions 20 : 4 : 2 : 1.

The chromatograms were tested for gibberellic acid-like activity by an assay based on growth of sections of the first leaf of etiolated wheat seedlings. Gibberellic acid produces little or no response in the coleoptile assays used for auxins, but leaf sections were shown by Hayashi and Murakami[5] to respond to gibberellin *A*, a substance similar in chemical and physiological properties to gibberellic acid. Four-day old wheat shoots, grown in the dark at 23° C., were cut close to the seed; 4 mm. sections were cut through both coleoptile and leaf 4 mm. from the base of the leaf. The chromatograms were divided into a number of pieces, which were moistened with water. Ten sections, each consisting of a leaf section still enclosed in a coleoptile section, were placed on each piece of paper and were incubated in a moist atmosphere in the dark at 23° C. for 48 hr. The final length of the leaf sections was measured with the aid of a projector. The wheat leaf test is exceedingly sensitive to gibberellic acid; sections on paper moistened with water increase in length by about 5 mm.; in 3×10^{-6} *M* gibberellic acid length increase is of the order of 7 mm. and even concentrations of 10^{-8} *M* cause an appreciable growth increase over controls. Growth is slightly enhanced by indolyl acetic acid, but only at considerably higher concentrations. This test is thus to some extent specific for gibberellic acid and related compounds.

Approximate R_F values for gibberellic acid and several auxins, using the solvent system described above, were: gibberellic acid, 0·46; indolyl acetic acid, 0·83; indolyl acetonitrile, methyl indolyl-acetate and indolyl butyric acid moved with the solvent front. In a number of experiments, extracts of shoots of two varieties of pea, Meteor (dwarf) and Improved Pilot (tall), have consistently shown a chromatogram zone of growth stimulation corresponding in R_F to gibberellic acid. Some chromatograms of pea extracts have also shown an active zone similar in R_F to indolyl acetic acid; but growth-inhibiting

substances, which are also found in the extracts, usually mask that area of the chromatogram.

Similar chromatograms sprayed with ethanolic Salkowski reagent showed no coloured spot typical of an indole compound, neither did they show the fluorescent zone characteristic of gibberellic acid after spraying with ethanolic sulphuric acid. This does not necessarily imply absence of indole compounds or gibberellic acid, but may be due to very low concentrations of such compounds on the paper.

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The Square Pyramidal Configuration in a Five-Co-ordinate Nitrosyl Complex

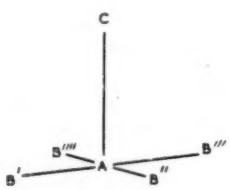
MOST molecules which have a five-co-ordinated central atom, and the structures of which have been accurately determined, have the shape of a trigonal bipyramid; for example, PF_5, $(CH_3)_3SbBr_2$, $Fe(CO)_5$. Nevertheless, in their study of valency theory, Daudel and Bucher[1] predicted that a five-co-ordinate molecule may in certain circumstances have a square pyramidal configuration. In their configuration (I), the central atom *A* is strongly bound to four atoms *B* at the corners of a square, these five atoms being co-planar; this square forms the base of a pyramid, and the fifth atom *C*, which is more weakly bound, is at the apex. They considered that this configuration would be most stable when the lower *d*-orbitals of the central atom are used in forming the bonds, that is, when the hybridization is dsp^2 rather than sp^3d.

Apart from the compound $[Ni(PEt_3)_2Br_2]$ prepared by Jensen and Nygaard, which is too unstable for detailed study but probably is square pyramidal, only two examples of this configuration appear to be well established. The infra-red and Raman spectra of iodine pentafluoride IF_5 require the molecular symmetry C_{4v}, that is, the configuration is square pyramidal, but the central iodine atom does not necessarily lie in the basal plane of the pyramid. The only example of this type of co-ordination which has so far been examined by X-ray crystallographic methods is K_2SbF_5, where the antimony atom appears to lie slightly below the basal plane of the square pyramid; the limits of accuracy claimed for this determination are rather wide, and it is not certain that this apparent departure from Daudel and Bucher's configuration is real. The molecule IF_5 and the ion $(SbF_5)^{=}$ are isoelectronic and in both cases the bonds must involve the upper *d*-orbitals of the central atom. It is simplest to regard the co-ordination as distorted octahedral, with one position occupied by a lone pair of electrons[2], the hybridization being sp^3d^2.

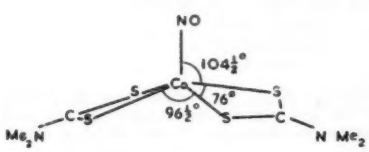
A molecule which fulfils more closely the conditions envisaged by Daudel and Bucher is *bis*-(NN-dimethyl dithiocarbamato)nitrosyl cobalt (II), $[Co(S_2CNMe_2)_2(NO)]$, and we have therefore determined its structure by X-ray crystallographic methods. It was first prepared by Malatesta, and Cambi reported it to be diamagnetic[3]; all the electrons are therefore paired, indicating that lower *d*-orbitals are used for σ-bond formation.

The crystals of this compound are monoclinic, space group $P2_1/c$, with four molecules in the unit cell; $a = 6{\cdot}49 \pm 0{\cdot}02$ A., $b = 13{\cdot}51 \pm 0{\cdot}05$ A., $c = 16{\cdot}95 \pm 0{\cdot}05$ A., $\beta = 116\frac{1}{2}°$. They were obtained by the slow evaporation at room temperature of a solution in chloroform, one of the few solvents in which the substance is appreciably soluble. The crystals, which form as prisms elongated along the *a*-axis, are opaque to light even when their thickness is as small as 0·01 mm. Their surfaces are highly reflecting like metallic mirrors, which indicates that some electrons in the molecule are bound rather loosely. All the crystals so far obtained have been twinned, and the X-ray analysis has therefore been limited to a study of the projections down the *a*- and *b*-axes.

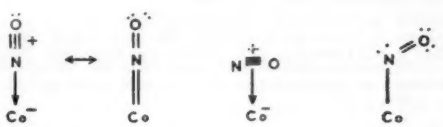
The crystal consists of discrete molecules, without any evidence of strong intermolecular forces. It became apparent very early in the analysis[4]—and subsequent refinement has confirmed—that the configuration of the molecule is indeed that of a square pyramid, or rather of a rectangular-based pyramid; but it is not exactly the configuration described by Daudel and Bucher. The central cobalt atom does not lie in the same plane as the sulphur atoms, but about 0·5 A. above it (II). The average cobalt–



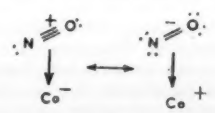
I



II



III IV V



VI

sulphur distance is 2·31 A., which is reasonably close to the sum of the octahedral radius for Co(II) and the tetrahedral radius for sulphur, 2·36 A. The inter-bond angles around the cobalt atom at the present stage of the analysis are shown in diagram II. The configuration is very similar to those derived theoretically, by two different methods, by Kimball[5] and by Linnett and Mellish.

The process of refining the structure so as to establish the positions of the lighter atoms is now nearing completion, and full details of the methods used and of the final results will be submitted for publication elsewhere. It is already clear that the nitric oxide group is not perpendicular to the basal plane of sulphur atoms, with the cobalt, nitrogen and oxygen atoms collinear (III), as has hitherto been supposed by analogy with carbonyl complexes[6]; nor is it parallel to the basal plane (IV), as in the π-type complexes, for example, of ethylene[7]. It lies between these two orientations, being inclined at an angle of approximately 135° to the vertical axis of the pyramid, and appears to be bound either by forming an electron-pair bond (V), or by the donation of π-electrons to the metal atom, the atoms being arranged unsymmetrically because of the difference between their electronegativities (IV). The existence of unsymmetrical π-complexes has already been shown by Holden and Baenziger's work on styrene palladous chloride[8], and we are indebted to Dr. L. E. Orgel for confirming that this type of bond can be justified on theoretical grounds in nitric oxide complexes. The arrangements in diagrams V and VI would both result in diamagnetism, but the angle Co—N—O of 135° is rather larger than would be expected for structure V. Structure VI fits our results better, but at the present stage of the analysis it is not possible to distinguish between V and VI with certainty.

We are indebted to Dr. J. Chatt, Dr. L. A. Duncanson and Dr. L. M. Venanzi, who also prepared the compound for us, for discussions on the structure.

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Photo-reduction of Pteridines

When a solution of 7-hydroxypteridine[1] was spotted on a sheet of Whatman No. 1 filter paper, irradiated with ultra-violet light (principally 254 mμ) for 5 min., and developed (by ascending chromatography) in various solvents, two spots appeared. One of these was identical with the starting material (unirradiated material was used as a control on the same piece of paper), and the other proved to be 5 : 6-dihydro-7-hydroxypteridine[1]. This reaction did not take place in aqueous solution (although 2 : 6-dihydroxypteridine[2] undergoes photochemical change in water), but it did if allyl-thiourea was present as a hydrogen donor (unirradiated controls were not reduced). 2- and 4-hydroxypteridine were found also to be photo-altered on paper; but the products have not yet been identified.

Photosensitive pteridine pigments are believed to be important in the visual process of insects[3]. It will be interesting to see if a cycle of photo-reduction followed by enzymic oxidation is involved.

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Optical Properties of 'Cellophane'

Some years ago, one of us[1] used commercial 'Cellophane' in conjunction with a polarizer and an analyser to produce colours in unstained microscopic sections of decalcified teeth. Subsequent investigation has shown that a sheet of this kind of 'Cellophane' exhibits the curious property of behaving like a half-wave plate. We do not think that this property can be explained in the usual way, that is, by 'Cellophane' thickness in conjunction with ordinary and extraordinary ray velocities, because it is improbable that the manufacture of commercial 'Cellophane' involves such precise control of thickness as the usual half-wave plate theory demands. We are therefore led to conclude that its surfaces are instrumental in giving 'Cellophane' this property.

If this phenomenon is indeed a surface, rather than a thickness, effect, it should appear with all colours equally. This would give 'Cellophane' the property of being a half-wave plate for all colours. In practice, when 'Cellophane' is viewed between two 'polars' it shows a definite coloration which becomes more marked when the thickness of the 'Cellophane' is increased (by using a number of sheets). This is indeed a thickness effect which makes it impossible to verify the supposed half-wave property precisely. Nevertheless, allowing for the limitations imposed by the thickness effect, we find, as already stated, that a 'Cellophane' sheet does satisfy the customary tests for a half-wave plate, no matter what colour of light be used. While the thickness effect can be explained in terms of current theory, we can think of no such explanation for an achromatic half-wave plate property dependent (as we believe) upon surfaces. Polythene sheets exhibit similar properties but less markedly.

Applications of the above-mentioned properties of 'Cellophane' and polythene to histology will be described later in the *Irish Journal of Medical Science*.

We should like to thank the Medical Research Council

of Ireland for apparatus used in this investigation, and Messrs. John Player and Sons, Dublin, for a generous gift of 'Cellophane'.

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Threshold Potential for the Low-Frequency Electric Discharge in Air

STUDIES of the threshold potential[1], V_m, for low-frequency (50 c./s.) discharges in atmospheric air dried over phosphorus pentoxide were made over a range of pressure, p, from 1 to 75 mm. of mercury, using cylindrical glass tubes with plane parallel glass ends as electrodes. V_m was indicated by a sudden rise in the current flowing through the discharge tube, the initiation of a glow characteristic of the gas, and the appearance of high-frequency pulses on the current waveform.

Fig. 1 shows the variation of V_m (a.c. peak value) with the product of pressure and inter-electrode distances, d in cm., (i) for hard 'Pyrex' glass electrodes and (ii) for soft soda glass electrodes. For comparison, values of the sparking potential, V_s, are also shown (iii) for brass electrodes under 50 c./s. a.c. excitation, and (iv) for mercury-contaminated copper electrodes under d.c. excitation recently reported by Llewellyn Jones and Davies[2].

It is seen that for a given value of $p \times d$, V_m (hard 'Pyrex' glass) is greater than V_m (soft soda glass), which in turn is greater than V_s (metal). The close agreement between the present values with brass electrodes and those of Llewellyn Jones *et al.* clearly indicates that the above difference is not due to the use of a.c. Moreover, the larger values of V_m with glass electrodes cannot be attributed to a difference in the work function of the electrodes, because differences in the breakdown potential for cathodes of different work function are a maximum near the minimum sparking potential and tend to become zero for higher pressures. In the present case, however, the difference $V_m - V_s$ is found to increase with $p \times d$. This difference may be attributed, at least in part, to a fall in potential on the glass electrodes depending on the resistivity, ρ, of the electrodes, which also changes in the sense that ρ (hard 'Pyrex' glass) is greater than ρ (soft soda glass) which is greater than ρ (metal).

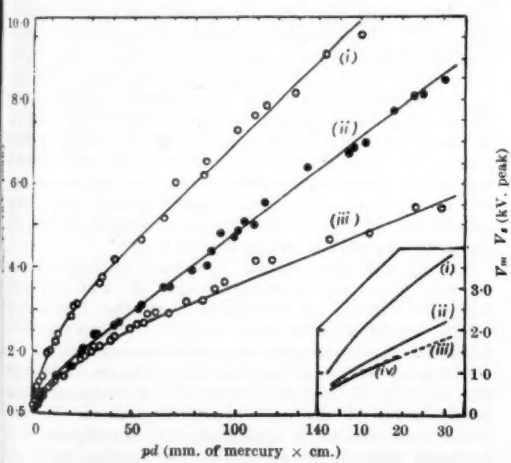

Fig. 1. Paschen's curves in air for various electrodes. (i) Hard 'Pyrex' glass electrodes; (ii) soft soda glass electrodes; (iii) brass electrodes; (iv) copper electrodes (in inset), after Llewellyn Jones and Davies
(i), (ii) and (iii): under a.c. excitation; peak values are plotted

Details of this work will be published elsewhere.

A similar difference in the Geiger threshold for Maze counters with external cathodes and that for Geiger counters with internal cathodes has been reported[3,4]. The plateau for Maze counters is also found to be appreciably longer[4]. Such results may also be due[5] to a corresponding fall in potential on the glass walls of the Maze counters.

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June 4.

[1] Joshi, S. S., *Curr. Sci.*, **8**, 548 (1939).
[2] Llewellyn Jones, F., and Davies, D. E., *Proc. Phys. Soc.*, B, **64**, 397 (1951).
[3] Aron, A., *Z. Phys.*, **134**, 622 (1953).
[4] Yasin, M., Ahmed, R., and Gill, P. S., *Nature*, **167**, 647 (1951); *Ind. J. Phys.*, **25**, 182 (1951).
[5] Cockroft, A. L., and Valentine, J. M., *J. Sci. Instr.*, **27**, 262 (1950).

A Compact Soil Perfusion Apparatus

Lees and Quastel[1] described an apparatus for the perfusion of soil samples which obviated the need for disturbing the soil during the experiment. Their design was later modified by Audus[2], who used a negative pressure for circulating the perfusate. This apparatus was rather fragile and required a considerable amount of incubator space. A modified design, using the same principle as the Audus apparatus, has been used here successfully for twelve months and the alterations did not apparently affect the efficiency of the perfuser compared with the earlier models.

The apparatus consisted of a 500-ml. Florence flask (Fig. 1) in which the neck was replaced by the tube D (15 cm. by 2·5 cm. internal diameter). The bottom of the tube D was constricted to prevent the soil column from falling into the flask. The side-arm C was bent at right-angles and extended up to the same height as the flask. A constriction, 1–2 mm. in diameter, was made at the point of fusion (B) to restrict the movement of liquid from C into the flask A. When the diameter of the constriction at B was greater than 2 mm., air was drawn directly into the flask rather than into the tube F. The tubes E and F had an internal diameter of 7 mm. and were fixed as shown in Fig. 1. The tube F was sealed into the right-angle bend of the side-arm C, which was found empirically to allow the optimal flow of air and perfusate into the tube F. The tube E led to a water pump and the air-flow was controlled by an adjustable clip. No constrictions in tubes E or F were found to be necessary. A piece of glass tubing (G) filled with cotton-wool was placed in the open

end of the side-arm *C* to prevent aerial contamination of the perfusate and to reduce the air flow into the tube *F*. The soil sample (30–50 gm. of soil crumbs) or small glass beads were placed in the tube *D* on a pad of glass wool and another pad was placed on top to prevent puddling of the soil. The rubber bung was replaced and 300 ml. 0·01 *M* ammonium sulphate was introduced into the flask via the side-arm.

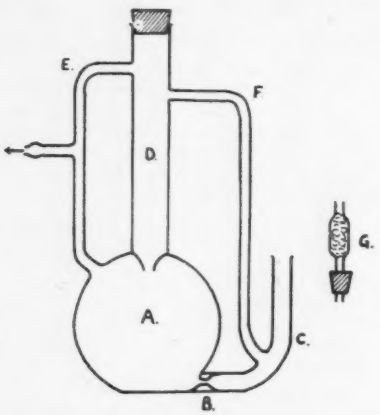

Fig. 1. Soil perfusion apparatus

The new apparatus was only 25 cm. high and could be housed in a small space as it did not require the support of a retort stand. The soil column was easily removed after the experiment by gentle shaking and the apparatus could be acid cleaned and then later sterilized in one piece, thus eliminating many of the breakages which occurred when assembling and dismantling the earlier models. The apparatus required no extensive adjustment prior to perfusion and worked for long periods without supervision. Finally, the apparatus was cheap and easy to make. The new design should be useful where large numbers of perfusers are used and the available incubator space is limited. Further details of the rate of nitrification by soils in this apparatus will be reported in greater detail elsewhere.

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Aug. 1.

[1] Lees, H., and Quastel, J. H., *Biochem. J.*, **40**, 803 (1946).
[2] Audus, L. S., *Nature*, **158**, 419 (1946).

Thermal Conductivity of Soil

In a recent communication[1] J. Webb overlooks that his calculation of the thermal conductivity of a cubic arrangement of spheres is based on an inadmissible simplification and in consequence he is led to a false conclusion. This is true also of Gemant's[2] article which is criticized by Webb. A rigorous analytical treatment of the identical problem in electrical conductivity was published by Lord Rayleigh[3]. Full elaboration of the theory, however, meets with mathematical difficulties.

Rayleigh's approximate formula leads to 0·00033 cal. cm.$^{-1}$ sec.$^{-1}$ deg. C.$^{-1}$ for the thermal conductivity in the numerical example discussed by Webb. From other considerations[4,5] it follows that this value is approximately 30 per cent too low. The value for a mineral dry soil at the same porosity (47·6 per cent) is about 0·0005 cal. cm.$^{-1}$ sec.$^{-1}$ deg. C.$^{-1}$ (ref. 4) and therefore practically of the same magnitude. It is trivial that both systems are not quite comparable because they have different geometry.

The theory of thermal conductivity of granular materials with special reference to soils has been discussed by me[4,5]. An approximate method for calculating the thermal conductivity of soils from their composition, moisture content and dry density has resulted. The method has been tested against a large body of consistent experimental results.

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Aug. 10.

[1] Webb, J., *Nature*, **177**, 989 (1956).
[2] Gemant, A., *J. App. Phys.*, **21**, 750 (1950).
[3] Rayleigh, W. R., *Phil. Mag.*, v, **34**, 481 (1892).
[4] Vries, D. A. de, *Med. Landbouwhogeschool Wageningen*, **52**, 1 (1950).
[5] Vries, D. A. de, Annexe 1952–51, *Bull. Inst. Int. du Froid, Paris*, 113 (1952).

In his article, Gemant directs attention to the non-rigorous nature of his method of determining the thermal conductivity of soil. His method, which I adopted in the communication to which Dr. de Vries refers, assumes that the lines of heat flow are parallel. Quite obviously, an assumption of this kind will introduce errors which will increase as the ratio of the conductivities of the two phases increases. For dry soil this ratio is of the order of 160 : 1, and the error involved in using my formula is very considerable.

For water-logged soil the ratio of the conductivities of the two phases is of the order of 7 : 1, and my formula yields the value 0·00486 cal. sec.$^{-1}$ cm.$^{-1}$ deg. C.$^{-1}$, which compares with an observed value quoted by Gemant of 0·005 cal. sec.$^{-1}$ cm.$^{-1}$ deg. C.$^{-1}$.

It would appear probable, then, that my formula would prove adequate for a composite material, in which conducting spheres are embedded in a matrix of lesser conductivity, provided that the ratio of the conductivities of the two components does not exceed say 10 : 1. This may be of little practical significance; but to my mind it justifies, to some extent, Gemant's treatment of the capillary wedge-shaped rings in damp as opposed to water-logged soil.

In my communication, I should perhaps have stressed the non-rigorous nature of the derived formula, instead of assuming that the interested reader would automatically consult Gemant's article in which the approximation is commented upon.

My purpose in writing initially was to challenge the validity of Gemant's method of determining the conductivity of dry soil. In this method, the air-phase conductance is neglected, and consequently it becomes difficult to reconcile the infinite value of the thermal resistivity of the hypothetical dry soil with the finite observed value for an actual dry soil. Gemant was forced to assume that the spheres were chipped to facilitate heat flow from solid to solid.

In other words, the model is tailored to suit observed values.

Using Gemant's own method, I attempted to show that the effect of the shunt air-conductance may not be neglected, with impunity, in a dry soil. That the method is not rigorous is of less concern to me than this point, namely, that the air-conductance must have a considerable influence upon the conductivity of dry soil. This does not appear to be in dispute.

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Sept. 15.

Effect of 'Rindite' on the Development of the Growth-substances in Potato Tubers

THE stimulating effect of 'Rindite' (ethylene chlorhydrin – ethylene dichloride – carbon tetrachloride 7 : 3 : 1) is extensively employed to break the rest period of potato tubers and thus to obtain two crops in a year. Although several articles dealing with the metabolism of the potatoes treated with 'Rindite' are known, the development of the growth-substances in the chemically treated tubers have not yet been analysed in detail. The purpose of this study was to elucidate the effect of 'Rindite' on the changes in the concentration of the growth-substances in the tubers.

The investigation was carried out on the 'Early Yellow' variety with a four-week rest period. Part of the freshly harvested tubers were exposed to the effect of 0·8 ml./kgm. 'Rindite' for 48 hr. and, after airing, were stored in wet sand. The untreated tubers were also stored. The sprouting of the treated potatoes began on the fifth day, while those of the controls began on the 28th day. Determinations of the growth-substances in the peelings of the treated tubers were carried out every second day for 12 days, that of the controls weekly for 42 days. The growth-substances were extracted with peroxide-free ether at 4° C. and the extractions were separated into acid and non-acid fractions. Chromatograms were made with *iso*propanol – ammonia – water and the growth-substance content of each 1 cm. paper-segment was examined by the *Avena* straight-growth test. The relative concentration of the growth-substances present could be inferred from the rate of the elongation of the coleoptile sections.

On chromatograms of the acid fractions of both the treated and untreated tubers, five active areas could be observed, as shown in Table 1.

Table 1

No.	R_F value	Bio-assay effect	Identification
1	0·10	stimulation	?
2	0·24	stimulation	indole-3-pyruvic acid
3	0·40	stimulation	indole-3-acetic acid
4	0·65	inhibition	?
5	0·87	stimulation	indole-3-acetonitrile

The substance having the R_F of 0·1 is unknown, though such a slowly moving accelerator has been demonstrated by Bennet-Clark and Kefford[1,2] and Nitsch[3] in several parts of plants. The substance with an R_F value of 0·24 is presumed to be indole-3-pyruvic acid. An inhibitor with the R_F of about 0·65 has been also found by several authors[1,2,4] in numerous plants including potatoes. Similarly, the presence of indole-3-acetonitrile in potatoes was demonstrated.

During the rest period and the sprouting, the concentration of the growth-promoting substances of the acid fractions in the stimulated tubers developed differently from that in the controls. In five days following treatment with 'Rindite' the concentration of indole-3-acetic acid in the peeling rapidly rose; even that of the precursors (indole-3-pyruvic acid and indole-3-acetonitrile) distinctly increased. After this rapid rise, a definite decrease in the concentration of both indole-3-acetic acid and its precursors was observed. The concentration of these substances in the spontaneously sprouting tubers increased more slowly. The level of the free auxins, however, rose gradually even after sprouting.

The treatment with 'Rindite' considerably accelerated the disappearance of the inhibitors. While in the control tubers the inhibitors disappeared only in about 30 days, in the treated tubers they disappeared in five days. These results are in agreement with Hemberg's[5] data.

On the chromatograms of the non-acid fractions the presence was noted of a growth-promoting substance (R_F 0·55) identified as indole-3-acetaldehyde. Its concentration in the treated tubers also rapidly rose until sprouting, then it dropped to the initial level. In the controls, however, no diminished concentration was observed after sprouting. The presence of indole-3-acetonitrile (R_F 0·87) was notep also in the non-acid fractions. Inhibitors in the non-acid fractions have been found only in traces. In the tubers treated with 'Rindite' when sprouted another non-acid growth-promoting substance appeared with about 0·8 R_F value. No such substance was found in the controls.

Details will be dealt with in another publication.

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June 25.

[1] Bennet-Clark, T. A., and Kefford, N. P., *Nature*, **171**, 645 (1953).
[2] Kefford, N. P., *J. Exp. Bot.*, **6**, 129 (1955).
[3] Nitsch, J. P., *Plant Physiol.*, **30**, 33 (1955).
[4] Blommaert, K. L. J., *Nature*, **174**, 970 (1954).
[5] Hemberg, T., *Physiol. Plant.*, **2**, 24 (1949); **5**, 115 (1952).

Preparation of Copepod Mounts for Taxonomic Work and for Permanent Collections

DURING an investigation of the microfauna of the shore at Whitstable, Kent, it was necessary to examine and to identify the many Harpacticoid copepods which occurred there. At the same time it was desirable to build up a type collection of these animals.

For purposes of identification one must be able to examine both dorsal and ventral aspects of these copepods at high magnifications. Hence preparations should be mounted on rectangular cover-glasses rather than on conventional microscope slides so that they may be equally accessible to study when inverted. In my experience, the following technique has proved satisfactory. The copepod is placed on a 2 in. × $\frac{3}{4}$ in. No. 1 cover-glass and killed with hot 70 per cent alcohol. Traces of salt are removed by flushing with cold 70 per cent alcohol, and the alcohol afterwards removed by filter paper. Polyvinyl lactophenol, with

chlorazol black in solution, is now applied to the specimen, which is then covered with a ½-in. diameter No. 0 cover-glass: by moving the top cover-glass with a fine mounted needle the animal may be correctly orientated.

Since the taxonomy of the Harpacticoid copepods largely rests on limb bristle characters it is essential that these bristles be well stained and clearly visible. By virtue of its permanence, chlorazol black has proved superior to lignin pink and cotton blue as a copepod stain in lactophenol preparations.

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Aug. 7.

Demonstration of Small-scale Water-currents by means of Milk

Small particles of relatively inert materials such as carmine, graphite, clay and starch are often used for showing up the currents of water produced by the feeding, swimming and other movements of small aquatic animals. Although such particles may be satisfactory for showing ciliary activity, when mucus is almost always present, in other cases they tend to disperse and sink, and are difficult to photograph. During work on the behaviour of barnacles we found that ordinary cow's milk offers a better means of detecting and measuring small water-currents, and is superior to artificial emulsions. We have since learned that milk has been used for showing the behaviour of aircraft models in a water-tunnel[1]. It seems possible, therefore, that the method may be of general use.

In our technique the animals are placed in a small vessel of still water and observed or photographed against a black background. The milk is injected into the water above the animal from a row of fine jets (Fig. 1, *A*) connected to a syringe. The syringe is operated manually by means of a screwed thread and knob, allowing the milk to be injected either in a steady stream or in blobs. The density can be adjusted by dilution with the medium or by varying the cream content. Normally the milk tends to clot slightly at the interface with sea water, and remains suspended as a trail, resembling thick smoke in air. The milk does not seem to have any harmful effect on marine animals; indeed, barnacles accept it as food, although if large quantities are administered it is found apparently unchanged in the fæcal pellets.

This method has enabled us not only to measure the external water currents set up by barnacle cirri, but also to establish the presence of an internal water-current passing through the mantle cavity during normal beating. The mantle current enters at the carinal end of the aperture near the mouth (Fig. 1, *B* and *C*), passes the filter net formed by the smaller cirri and mouth parts[2], flows around the branchiæ and is ejected as a strong jet between the prosoma and rostrum on the downward beat of the cirri (Fig. 1, *D*). A circulation of this type seems universal in cirripedes, and has been demonstrated in the following species: *Verruca stroemia* (O. F. Müller), *Chthamalus stellatus* (Poli), *Balanus amphitrite* (Darwin), *B. balanoides* (L.), *B. crenatus* Bruguière, *B. hameri* Ascanius, *B. improvisus* Darwin, *B. perforatus* Bruguière, *B. porcatus* da Costa, *B. spongicola* Brown, *Elminius modestus* (Darwin),

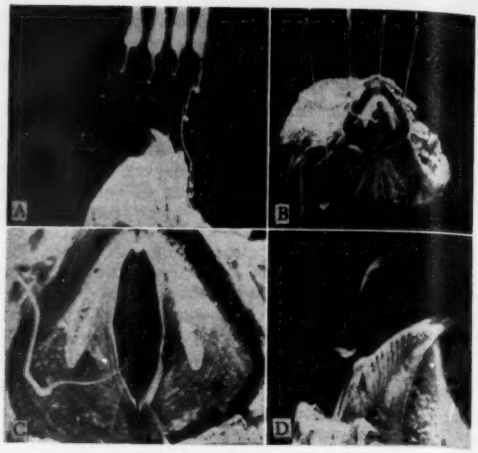

Fig. 1. *Balanus porcatus*: *A*, Side view with cirri extended showing displacement of all milk trails; *B*, top view with valves beginning to open, showing three trails drawn into mantle cavity; *C*, close-up of *B* with single trail; *D*, side view in close-up during downward beat of cirri, exhalant current indicated by upward loop in milk trail. (All enlarged from 16 mm. reversal film)

Acasta spongites (Darwin), *Pyrgoma anglicum* Leach, *Hexelasma hirsutum* Hoek, *Alcippe lampas* Hancock.

The mantle circulation depends on the movement of the prosoma and valves, and can be maintained when the movement of the larger cirri is scarcely noticeable; conversely, it is reduced during particularly active movements of the cirri.

These investigations will be published in detail elsewhere. In the meantime a ciné film demonstrating the milk technique, together with other aspects of the behaviour of barnacles, is available.

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Aug. 13.

[1] Dessoutter, D. M., *The Times* "Survey of British Aviation", 17 (1955).
[2] Southward, A. J., *Nature*, **175**, 1124 (1955).

Letters of J. Purkyně

Having recently completed an edition of the complete works of J. Purkyně, I am preparing to publish his letters. In this connexion I am seeking especially letters which he wrote to the British physiologist, Martin Barry (1802–55), and also any letters which show Purkyně's relations with the Royal Society. I should be grateful if anybody possessing letters by or concerning Purkyně, or anybody knowing of their whereabouts, would write to me.

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Aug. 7.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Sunday, November 11

BRITISH BROADCASTING CORPORATION (Home Service), at 9.15 p.m. —Sir Edward Appleton, F.R.S.: "Science and the Nation". (First of six Reith Lectures. Further lectures on November 18, 25, December 2, 9 and 16.)

Monday, November 12

BRITISH OCCUPATIONAL HYGIENE SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 10.30 a.m.—Conference on "Fires in Industry".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. W. Ross Ashby: "Basic Strategies of Research in Biological Systems".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. H. Grüneberg: "Genes in Mammalian Development".*

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Prof. F. Bergel: "The Study of Biologically Active Agents as a Vocation" (Jubilee Memorial Lecture).

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the WOOLWICH POLYTECHNIC SCIENTIFIC SOCIETY at the Woolwich Polytechnic, London, S.E.18), at 7.30 p.m.—Prof. R. L. Wain: "Plant Growth-Regulating Substances".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Lieut.-Cmdr. M. J. N. Foster, R.N.: "Operation 'Deepfreeze 1' ".

Tuesday, November 13

INSTITUTION OF MECHANICAL ENGINEERS, AUTOMOBILE DIVISION (at 1 Birdcage Walk, London, S.W.1), at 4.30 p.m.—Papers on "Research in Automobile Stability and Control".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Prof. L. F. Wiggins: "Chemistry and the Sugar Cane".

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at 6 Buckingham Gate, London, S.W.1), at 5.30 p.m.—Dr. P. Payne: "The Mechanical Properties of Soil in Relation to Basic Cultivation".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. L. Barden and Mr. P. C. G. Isaac: "The Effect of Synthetic Detergents on the Biological Oxidation of Sewage".

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at 14 Belgrave Square, London, S.W.1), at 5.30 p.m.—Mr. H. L. Riley: "The Manufacture of Phthalic Anhydride by the Fluidized Catalyst Method".

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON GRADUATE AND STUDENT SECTION (at Savoy Place, London, W.C.2), at 6.30 p.m.— Dr. M. V. Wilkes: "Digital Computers and how they may help the Engineer" (The Students' Lecture).

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Dr. E. W. Still: "Air Conditioning of Aircraft".

Wednesday, November 14

PHYSICAL SOCIETY, COLOUR GROUP (in the Lecture Theatre of the Institute of Ophthalmology, Judd Street, London, W.C.1), at 3.30 p.m. —Mr. D. L. Simms: "Colour in Fire Research".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. A. H. Lee: "Some Problems raised by the Regional Variations in Intellectual Ability in Britain".*

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO AND TELECOMMUNICATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.— Scientific Papers.

UNIVERSITY OF LONDON (at the School of Pharmacy, 17 Bloomsbury Square, London, W.C.1), at 5.30 p.m.—Brigadier-General Sir Harold Hartley, F.R.S.: "The Contributions of Pharmacy and Chemical Engineering to World Needs".* (Further lecture on November 15.)

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, SOCIAL PHILOSOPHY SECTION (in the Reynolds Hall, College of Technology, Manchester), at 5.45 p.m.—Prof. T. E. Chester: "Some of the Human Problems Present in Modern Industrial Society".

ROYAL INSTITUTE OF CHEMISTRY (at the Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Annual General Meeting.

SOCIETY FOR ANALYTICAL CHEMISTRY, BIOLOGICAL METHODS GROUP (at "The Feathers", Tudor Street, London, E.C.4), at 6.30 p.m. —Discussion Meeting on "Biological Methods in the General Analytical Laboratory".

Thursday, November 15

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. A. V. Hill, F.R.S.: "The Effect of Potassium on the Resting Metabolism of the Frog's Sartorius"; Mr. G. A. Horridge: "The Co-ordination of the Protective Retraction of Coral Polyps".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.— Mr. Edward Rich: "A New Process for Pneumatic Stowing: Its Development and Introduction at the Rio Tinto Mines, Spain"; Mr. M. R. Goldick: "Some Developments in Tailing Disposal at Roan Antelope Copper Mines, Northern Rhodesia".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—The Fisheries Laboratory, Lowestoft. Papers by Mr. P. M. J. Woodhead, Mr. A. D. Woodhead and Mr. J. E. Shelbourne.

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.— Annual General Meeting. Sir Geoffrey Taylor, F.R.S.: "Some Simple Problems in Fluid Dynamics".

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5 p.m.—Dr. Grey Walter: "The Electrical Activity of the Brain".*

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5 p.m.—Dr. Dorothy Needham: "The Biochemistry of Muscular Action".* (Further lecture on November 22.)

UNIVERSITY OF LONDON, INSTITUTE OF EDUCATION (at Goldsmiths' College, New Cross, London, S.E.14), at 5 p.m.—Prof. J. A. Lauwerys: "Education for Social Progress in Under-developed Countries".*

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. W. H. J. Vernon: "Metallic Corrosion and Conservation". (Fourth of a series of six lectures on "The Conservation of Natural Resources".)

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the Institute of Laryngology and Otology, Grays Inn Road, London, W.C.1), at 5.30 p.m.—Miss P. H. Strange: "Sensations of Pitch".

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE AND MICROBIOLOGY GROUPS (at 14 Belgrave Square, London, S.W.1), at 6.15 p.m.— Meeting on "Recent Developments in Virus Research". Mr. F. C. Bawden, F.R.S.: "Plant Virus Diseases"; Dr. Kenneth M. Smith, F.R.S.: "Viruses Attacking Insects".

INSTITUTION OF MECHANICAL ENGINEERS, INTERNAL COMBUSTION ENGINE GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Are Diesel Engines an Interim Phase in Rail and Road Transport Development?"

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Reading of Original Papers to commemorate the 70th Birthday of Sir Ian Heilbron, F.R.S.

Thursday, November 15—Friday, November 16

INSTITUTE OF PHYSICS and THE LONDON AND HOME COUNTIES REGIONAL ADVISORY COUNCIL FOR HIGHER TECHNOLOGICAL EDUCATION (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2)—Joint Conference on "Degree and Diploma Courses in Applied Physics".

Friday, November 16

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion on "Bombardment of the Earth by Meteors and Meteorites". Speakers: Prof. H. Bondi (who will read a contribution sent by Mr. T. Gold), Dr. J. G. Davies and Dr. M. H. Hey.

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5.15 p.m.—Mr. J. E. D. Williams: "Navigational Aspects of Turbo-Prop Operations over the North Atlantic".

ROYAL METEOROLOGICAL SOCIETY (in the Conference Hall, County Hall, London, S.E.1), at 5.30 p.m.—Mr. N. Bradbury: "Aviation Meteorology"* (Lecture for Sixth-form Scholars).

INSTITUTION OF MECHANICAL ENGINEERS, APPLIED MECHANICS and LUBRICATION GROUPS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Dr. A. W. Crook: "Simulated Gear Tooth Contacts—Some Experiments upon their Lubrication and Subsurface Deformations".

INSTITUTION OF CHEMICAL ENGINEERS, GRADUATES AND STUDENTS SECTION (at Caxton Hall, Westminster, London, S.W.1), at 6.30 p.m. —Mr. G. A. Dummett: "Research and Development in a Chemical-Plant Manufacturing Firm".

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Sir Charles Dodds, F.R.S.: "Pharmaceutical Applications of Modern Biochemistry".* (Sixth of ten University Extension Lectures on "Technology and Industry". Further lectures on November 23, 30, December 7 and 14.)

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. I. A. Richmond: "Roman Military Engineering".

Saturday, November 17

BIOCHEMICAL SOCIETY (at the Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5), at 2 p.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BIOCHEMIST, Senior grade (with a first- or second-class honours degree), IN THE PATHOLOGICAL DEPARTMENT, for duties which include both routine hospital biochemistry and work connected with the investigations into the uses of radioactive isotopes in medicine—The Secretary, Liverpool Radium Institute Management Committee, 1 Myrtle Street, Liverpool 7 (November 17).

LECTURER (with a good honours degree, and preferably a teaching diploma and experience) IN PHYSICS at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (November 20).

CHEMIST (METALLURGIST) (with an honours degree in metallurgy, chemistry or chemical engineering, or Associate of the Royal Institute of Chemists or Institution of Metallurgy, or equivalent qualifications) at the Ministry of Supply Royal Ordnance Factory, Birtley, Co. Durham, for research and development work in connexion with new manufacturing processes, the control of laboratory staff, and the preparation of reports for publication—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.740/6A (November 23).

ASSISTANT LECTURER (preferably with a special interest in petrology) IN GEOLOGY—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1 (November 26).

RESEARCH OFFICER (honours graduate in agricultural science and satisfactory postgraduate experience in crop and grassland husbandry) IN THE DEPARTMENT OF AGRICULTURE'S PEATLAND EXPERIMENTAL STATION at Glenamoy, Co. Mayo—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (November 27).

ASSISTANT PRINCIPAL OF THE WRIGHT-FLEMING INSTITUTE OF MICROBIOLOGY—The Secretary, Wright-Fleming Institute, St. Mary's Hospital Medical School, Paddington, London, W.2 (November 30).

CHAIR OF ANTHROPOLOGY in the University of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 30).

LECTURER IN AGRICULTURAL ZOOLOGY at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 30).

PHYSICISTS or ENGINEERS (university graduates with basic training in physics or engineering including an honours degree, and evidence of research experience and ability) IN THE WOOL TEXTILE RESEARCH LABORATORY, Commonwealth Scientific and Industrial Research Organization, Geelong, to take charge and assist with new projects—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (November 30).

SCIENTIFIC OFFICER (over 24, with an honours degree in zoology or botany (preferably with qualifications in both), or agriculture or forestry or equivalent, and a special interest in some branch of natural history), for conservation and regional work in South Wales—The Establishment Officer, The Nature Conservancy, 19 Belgrave Square, London, S.W.1 (November 30).

SENIOR RESEARCH ASSISTANT or RESEARCH ASSISTANT, for research on the electrochemistry of salts of low melting points—Prof. A. R. Ubbelohde, F.R.S., Chemical Engineering Department, Imperial College, London, S.W.7 (November 30).

LECTURER or ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Registrar, The University, Sheffield (December 1).

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF GEOLOGY—The Secretary and Registrar, The University, Southampton (December 5).

LECTURER or ASSISTANT LECTURER IN GAS ENGINEERING, and a LECTURER or ASSISTANT LECTURER IN GENERAL FUEL SCIENCE—The Registrar, The University, Leeds (December 10).

CHAIR OF EXTRACTION METALLURGY in the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (December 12).

LECTURER (with special qualifications and experience in human geography) IN GEOGRAPHY; and a LECTURER (with an honours degree or higher in psychology) IN PSYCHOLOGY at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Tasmania, December 15).

READER IN PHYSICS at the University of Sydney, Australia, to assist the Professor in the direction of a laboratory concentrating on problems in high energy nuclear physics using cosmic rays and accelerators—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 15).

SENIOR LECTURER or READER IN PROTEIN CHEMISTRY, and a LECTURER (with research experience in biochemistry or organic chemistry, preferably, but not essentially with plant material) IN AGRICULTURAL BIOCHEMISTRY at the Waite Agricultural Research Institute—The Registrar, University of Adelaide, Adelaide, South Australia (December 15).

CHAIR OF BIOCHEMISTRY in the University of Malaya—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (December 31).

SENIOR LECTURER or LECTURER (Grade I or Grade II) IN TROPICAL AGRICULTURE, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (December 31).

AGRICULTURAL LIBRARIAN (with a university degree in agricultural economics, agriculture or biological science, and some experience of technical library work, especially abstracting) IN THE DEPARTMENT OF AGRICULTURE, Western Region, Nigeria, to take charge of the Departmental Technical Library, to make abstracts and prepare symposium for the use of Technical Officers, and to assist with the preparation of articles for publication, etc.—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/416/019.

ASSISTANT LIBRARIAN at the University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

ASSISTANT TEACHER, Grade B, IN PHYSIOLOGY AND PHARMACOLOGY, in the Department of Pharmacy, College of Technology, Liverpool—The Director of Education, 14 Sir Thomas Street, Liverpool 1.

CURATOR/TECHNICIAN (preferably with special interests in palæontology) IN THE DEPARTMENT OF GEOLOGY, for duties which will include the care and cataloguing of geological laboratory and museum specimens and collections—The Registrar, University College, Singleton Park, Swansea.

FISHERIES OFFICER (FISH CULTURE RESEARCH) (with an honours degree in biology with emphasis on zoology; appropriate knowledge of chemistry and statistical methods; ability to read French and possibly German, and preferably experience of similar or related work) with the Federation of Nigeria, to undertake research into the pond culture of local species of fish and into the chemistry and plankton populations of fish ponds to ensure the most profitable use of available nutrients, food-stuffs and fertilizers—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.65/14/01.

LECTURER (with a university degree, and preferably a qualification in engineering, and some experience in industry and teaching) IN MATHEMATICS—The Registrar, Loughborough College of Technology, Loughborough.

PHYSICIST, Senior grade (with a knowledge of X-rays, radium and radioactive isotopes), IN THE RADIOTHERAPY DEPARTMENT, for duties which concern routine radiotherapy physics, and the applications of radioactive substances in other branches of medicine—The Secretary to the Board of Governors, Charing Cross Hospital, London, W.6.

PLANT PATHOLOGIST (with an honours degree in botany, or natural science including botany) IN THE DEPARTMENT OF AGRICULTURE, Kenya, to assist in producing new varieties of wheat and other cereals resistant to the increasing number of rust strains—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/7/030.

PRINCIPAL/SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in physical or inorganic chemistry, and experienced physical chemist with a special interest in thermodynamics) to assist in the direction and carrying out of research on a variety of subjects—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. 1311/34.

READER, SENIOR LECTURER or LECTURER IN (*a*) INORGANIC CHEMISTRY and (*b*) PHYSICAL CHEMISTRY at the University of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

SENIOR TECHNICIAN (with F.I.M.L.T. or equivalent qualification, and experience in hospital biochemistry) IN THE DEPARTMENT OF CHEMICAL PATHOLOGY—The Secretary, Guy's Hospital Medical School, London, S.E.1.

STATISTICIAN/PHYSICIST (preferably with a university degree or at least H.S.C. in science subjects or G.C.E. (advanced level) in two science subjects, or equivalent qualifications, and relevant experience), IN THE ELECTRONICS DIVISION, for work associated with nucleonic instrumentation reliability studies—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting Ref. 611/34.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Electrical and Allied Industries Research Association. Technical Report L/T346: Realizability, Kramers-Bronig Relations, and Fuoss-Kirkwood Dielectric. By H. Pelzer. Pp. 5. 4*s.* 6*d.* net. Technical Report L/T354: A Thermodynamic Treatment of Ferroelectricity and Antiferroelectricity in Pseudo-Cubic Dielectrics. By L. E. Cross. Pp. 18. 3*s.* net. (Leatherhead: British Electrical and Allied Industries Research Association, 1955 and 1956.) [189

What We are Doing, No. 5 (July, 1956). (Bulletin of the British Paper and Board Industry Research Association.) Pp. 28. (Kenley: British Paper and Board Industry Research Association, 1956.) [189

The Mond Magazine. No. 1, July 1956. Pp. 24. (London: The Mond Nickel Company, Ltd., 1956.) [189

Ministry of Health. Trial Case Lenses: Report of a Committee appointed by the Minister of Health. Pp. 25. (London: H.M. Stationery Office, 1956.) 1*s.* 9*d.* net. [189

Department of Scientific and Industrial Research. Forest Product Research Bulletin No. 37: Working Stresses for Structural Softwoods. By J. G. Sunley. Pp. iv+14. (London: H.M. Stationery Office, 1956.) 1*s.* 3*d.* net. [189

Marine Biological Station, Port Erin. Annual Report for 1955 (No. 68). Pp. 38. (Liverpool: Liverpool University Press, 1956.) 3*s.* [189

Unmeasured Hazards: an Analysis of the Effects of Tests of Atomic and Thermonuclear Weapons. Prepared by a Committee of the World Federation of Scientific Workers. Pp. 40. (London: World Federation of Scientific Workers, 1956.) 2*s.* [189

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